Protecting Salmon and Steelhead

Endangered Species Act
Federal Columbia River Power System
2008 Progress Report Summary

December 2009

In May 2008, NOAA Fisheries issued a new Biological Opinion (BiOp) on the operation of the dams that make up the Federal Columbia River Power System. This opinion considered a Biological Assessment and a suite of actions proposed by the Bonneville Power Administration, the Bureau of Reclamation, and the U.S. Army Corps of Engineers (the Action Agencies) to protect salmon and steelhead across their life cycle. It also provided NOAA Fisheries with scientific analysis under the Endangered Species Act (ESA) and an extensive list of Reasonable and Prudent Alternative (RPA) actions to avoid jeopardy to the fish.

Based on the BiOp, the Action Agencies committed to implementing actions to improve the survival of salmon and steelhead listed under the ESA, including the use of spill and surface passage structures at dams, management of water releases from storage reservoirs, expanded control of predators that prey on young salmon, restoration of tributary and estuary habitat, and

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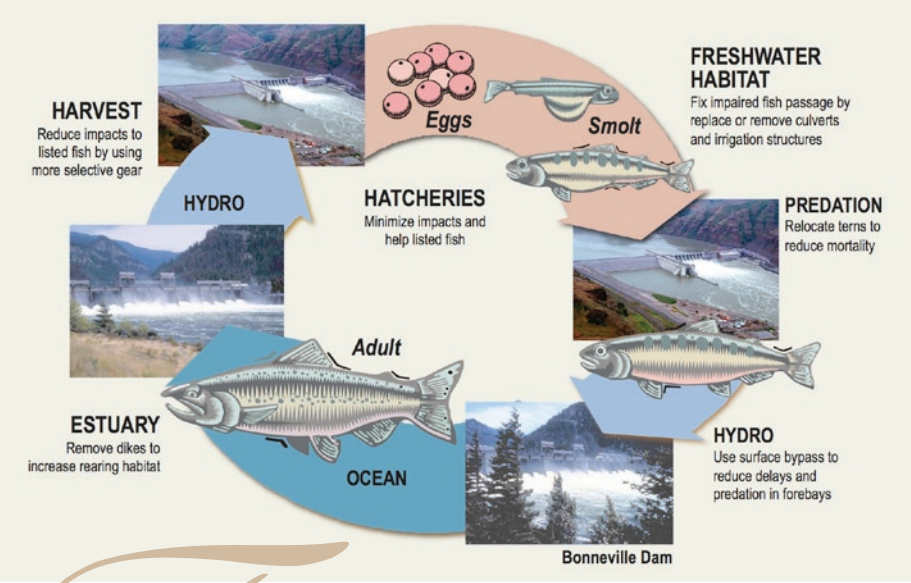

All-H Problems: All-H Solutions

Samples from the 2008 FCRPS BiOp

Throughout the Columbia River basin, tribal, state, local, and federal parties are working in partnership to protect and restore stocks of salmon and steelhead. Thirteen stocks of these fish are listed as threatened or endangered under the Endangered Species Act (ESA). Many parties in the region are working together to protect and enhance important habitats, improve hatchery and harvest practices, and enhance river conditions for migrating fish. Federal agencies alone are spending more than $400 million each year on this effort.

The goal is to provide healthier places for ESA-listed salmon and steelhead to spawn and grow, and a safer migration path to and from the ocean – improving fish survival, abundance, and productivity. Recovering species that have such complex life cycles—that spawn and rear in freshwater rivers but spend most of their lives in the ocean—requires a comprehensive approach.

The federal agencies that manage the system of dams in the basin include the U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration (BPA), collectively known as the Action Agencies. They consult with NOAA Fisheries on dam operation, including activities that improve conditions for fish. Operating the dams for flood control, power production, irrigation, navigation, and other uses affects the flow of the river and water conditions. In addition, the mainstem dams are in the path of salmon

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implementation of hatchery reforms. The Action Agencies also entered into the Columbia Basin Fish Accords with two states and five tribes to promote regional partnerships and "on-the-ground" implementation. The Action Agencies are responsible for providing annual progress reports detailing the implementation and progress of the RPA.

In September 2009, the BiOp was enhanced through a Memorandum of Agreement with the State of Washington and an Adaptive Management Implementation Plan (AMIP, at *http://www.salmonrecovery.gov/BiologicalOpinions/FCRPS/2008Biop.aspx*) prepared by the Obama Administration after considering the views of the court and the parties and conducting a scientific review. The AMIP includes accelerated actions, additional research related to fish status and climate change, and precautionary use of biological triggers and contingency plans in case there is an unexpected, significant fish decline. These new ESA provisions are being implemented now but were not in place for 2008.

To review the FCRPS BiOp in its entirety, go to *https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=27149*.

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This report is produced by the "Action Agencies"—the U.S. Army Corps of Engineers Northwestern Division, Bureau of Reclamation Pacific Northwest Region, and Bonneville Power Administration.

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and steelhead as they migrate many miles to the ocean to mature and return upriver to spawn in inland streams and tributaries.

This report summarizes the significant actions implemented by the Action Agencies in 2008 to protect ESA-listed salmon and steelhead affected by the operation of the Federal Columbia River Power System (FCRPS).[1] It describes the status of RPA actions being implemented across the fish life cycle for that calendar year. The actions described in this annual report are focused on achieving biological performance standards, achieving programmatic performance targets, and addressing factors that limit certain life stages for specific evolutionarily significant units (ESUs) or distinct population segments (DPSs) of salmon and steelhead. Adaptive management is the process the agencies use to make annual adjustments to actions based on new scientific information, to meet biological performance objectives effectively and efficiently.

The region as a whole is making noticeable progress in fish conservation. Over the past decade, fish survival through the federal dams has improved significantly. Fisheries that were closed for a decade or more have been reopened as fish numbers have increased. Step by step, regional efforts are improving the quality of salmon habitat and increasing knowledge about salmon and steelhead life cycles and requirements. The agencies remain committed to continued collaboration and coordination with other regional parties working toward the common goal of sustainable Pacific salmon and steelhead populations. The full FCRPS 2008 Annual Progress Report, which includes the *Reasonable and Prudent Alternative (RPA) Summary Table: Actions and Accomplishments, Detailed Description of RPA Action Implementation,* and *Project Tables for RPA Action Implementation*, is available online at *www.salmonrecovery.gov*. Previous FCRPS progress reports and information on other salmon and steelhead protection efforts are available on websites listed at the end of this document.

Figure 1. Map of the Columbia River Basin Showing Action Areas, Dams, and Listed Species. The Columbia River and its tributaries form the dominant water system in the Pacific Northwest and are a heavily used regional resource.

[1] *The FCRPS includes 14 major dams and power plants on the Columbia and Snake rivers. These dams and power plants are operated as a coordinated system (including with Canada) to meet multiple purposes as authorized by Congress.*

2008 Fish Status and Environmental Conditions

Adult Fish Returns and Trends

One way the Pacific Northwest tracks how well salmon and steelhead are doing is by comparing the numbers of fish that return each year to spawn. Many dams have fish counting stations where annual index tallies are made of the various species as they swim up the fish ladders. In 2008, more than 1.3 million adult and jack salmon and steelhead were counted as they passed Bonneville Dam. (Jack salmon are young males that mature and return to spawning grounds earlier than others in their age class.) This number exceeds historical averages (i.e., for 2000 and earlier) and is slightly above the 10-year average (Figure 2).

As shown in Table 1, counts in 2008 of adult and jack summer Chinook, coho, and sockeye passing Bonneville Dam all exceeded the 10-year average, and spring Chinook, fall Chinook, and steelhead counts were below the 10-year average. In a typical year, about 80 percent of all returning adult salmon are of hatchery origin, though the actual percentage varies by species.

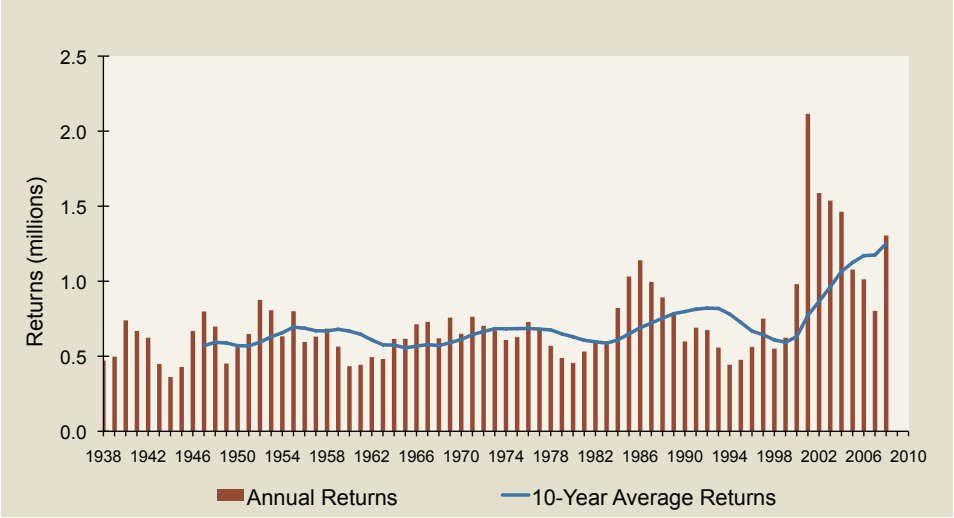

Figure 2. Adult and Jack Salmon/Steelhead Returns at Bonneville Dam, 1938 to 2008 (Includes Hatchery and Natural-Origin Fish).

Table 1. Adult Salmon and Steelhead Returns at Bonneville Dam, 2008 and 10-Year Average.

Species	2008	10-Year Average
Chinook – Total [1]	587,428	670,558
Spring Chinook [2]	143,139	172,107
Summer Chinook	89,892	87,086
Fall Chinook	354,397	411,365
Steelhead	357,820	361,078
Sockeye	213,607	78,642
Coho [3]	146,059	119,860
Chum and Pinks	135	192
TOTALS of all species for period	1,305,049	1,230,330

Period of 10-year average 1999–2008. All data from the U.S. Army Corps of Engineers' Fish Passage Report 2008, Table 18, except as noted below.

[1] *Chinook data from monthly values in Fish Passage Report 2008, Table 19, except that values for 1994-2002 are from monthly values in Fish Passage Report 2002, Table 18. Values include jacks.*

[2] *Assumed Chinook run dates: spring = Jan 1–May 31, summer = June 1–July 31, fall = Aug 1–Dec 31.*

[3] *Includes jacks.*

Adult Fish Survival

Survival rates of ESA-listed adult Chinook and steelhead through the FCRPS are at or slightly below adult passage performance standards, using the methodology in the 2008 FCRPS BiOp and updated harvest estimates (see Table 1). Five-year rolling average survival rates are within 1 to 2 percent below the BiOp goals for all Snake River (SR) ESUs and Upper Columbia River (UCR) ESUs that migrated in river as juveniles. This discrepancy is likely related to three factors: modifications to operations and structures at the dams to increase juvenile survival that in some instances may also increase adult passage times; predation on spring Chinook that fall back at Bonneville Dam; and additional unquantifiable levels of mortality from unreported or delayed mortality caused by fisheries and unaccounted levels of straying. Determining optimal spill levels for all life-cycle stages, modifying operations or structures with known adult passage problems, and managing sea lion predation should help improve adult survival rates in the future.

Juvenile Fish Survival

Juvenile salmon and steelhead that migrate to the ocean through the Snake and Columbia rivers are either transported by barge or truck around the lower river dams or left "in river" to migrate past the dams. Total juvenile fish survival, also known as system survival, is a combination of in-river and transportation survival. The COMPASS model was used to estimate FCRPS system survival for the 2008 migration of Snake River spring Chinook and steelhead. The model estimated that 2008 system survival was 58.0 percent for Chinook and 67.1 percent for steelhead. Actual 2008 system survival results will be calculated when adult returns are completed.

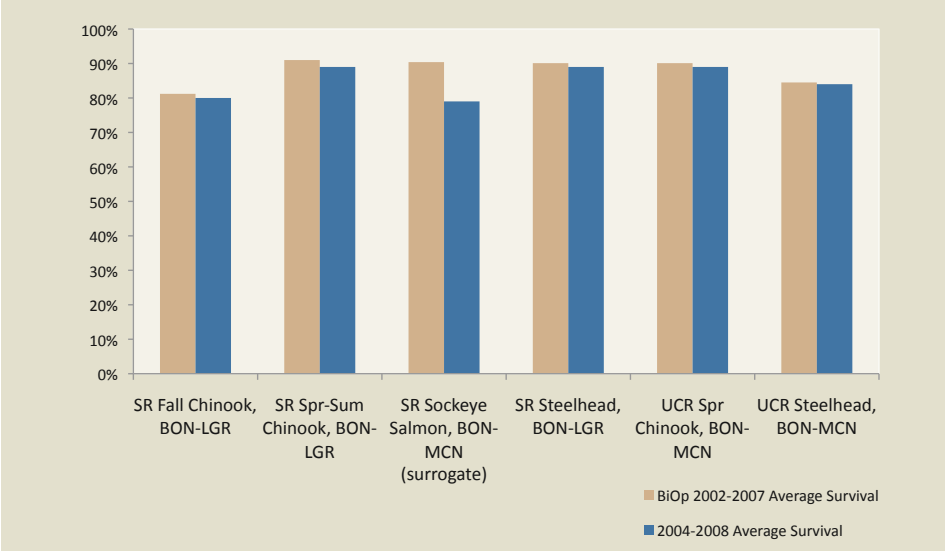

Figure 3. 2008 FCRPS BiOp Adult Survival Standard and Summary of 5-Year Rolling Average Adult Survival of Adults that Migrated in River as Juveniles, Based on PIT Tag Conversion Rates of Snake River (SR) and Upper Columbia River (UCR) ESUs.

(BON = Bonneville, MCN = McNary, LGR = Lower Granite) (Source: May 5, 2008, Biological Opinion and NOAA Fisheries – Portland, unpublished data [Bellerud]).

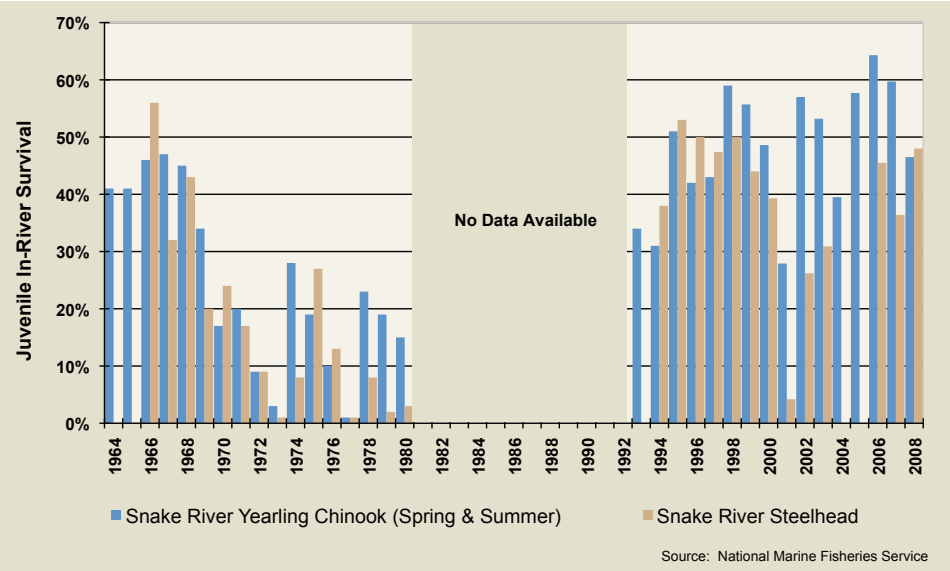

Figure 4. In-River Survival Estimates (Hatchery and Wild Combined) for Snake River Chinook Salmon and Steelhead.

(Steelhead estimates for 2004 and 2005 are unavailable due to lower PIT tag detection efficiency at Bonneville Dam. Survival estimates not available for 1981 through 1992.)

The percentage of fish that travel in river compared to the percentage transported has ranged from 45 to 90 percent, depending on a number of factors, such as projected river flow volumes, how much spill is provided, and how well fish are attracted to juvenile fish bypass systems. Approximately 98 percent of the transported juveniles survive to the point of release below Bonneville Dam. Because additional "delayed mortality" may occur after the fish are released, research is being carried out under the BiOp to better understand any delayed effects of transport.

The BiOp also established an in-river survival performance metric for Snake River spring/summer Chinook and steelhead; this metric is intended to provide important information for both the annual adaptive management process and the comprehensive evaluations in 2013 and 2016. The Action Agencies empirically measured in-river survival for 2008 (Lower Granite to Bonneville and McNary to Bonneville) and compared that with the survival estimates derived by running COMPASS (with prospective survival estimates for the actions that were implemented at the start of the 2008 migration season using 2008 river conditions, fish migration patterns, and dam and transport operations). Results indicate that the benefits from the RPA actions implemented to date are likely accruing as expected.

In-river survival estimates for Snake River spring Chinook, Snake River steelhead, and Columbia River spring Chinook were similar to expected survival targets based on the COMPASS model. The in-river survival of both Snake River Chinook and Upper Columbia spring Chinook was lower than predicted by the COMPASS model, although the associated 95 percent confidence intervals encompassed the model estimates. The measured in-river survival for Snake River steelhead in 2008 exceeded the COMPASS estimate. As with the Chinook salmon estimates, the confidence intervals for Snake River steelhead overlapped the COMPASS estimate. In-river survival estimates for Upper Columbia steelhead could not be generated in 2008, so a comparison with the COMPASS model was not possible. NOAA Fisheries' 2008 in-river survival report[2] offers several potential explanations for the lower than expected survival between McNary Dam and Bonneville Dam in 2008 for both the Snake River and Upper Columbia Chinook salmon ESUs. One potential explanation is related to the installation of two top spillway weirs (TSWs) at John Day Dam. Although survival rates[3] were high over the new structures, it is possible that altered tailrace conditions made migrating fish in river more vulnerable to predators.

[2] *Faulkner, J.R., S.G. Smith, W.D. Muir, D.M. Marsh, and J.G. Williams. 2009. Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids through Snake and Columbia River Dams and Reservoirs, 2008.*

[3] *Generally, juvenile dam survival estimates represent survival of the treatment group relative to the control group.*

In 2009, additional avian predation prevention measures such as increased harassment to exclude birds from portions of the tailrace were employed as an adaptive management response.

Water Year and Streamflow Summary

The Columbia Basin experienced average water conditions in 2008. Snake River flow volume was near average throughout April 2008 but increased to above average for most of May because of late-season thaw of larger-than-average snowpack. In addition, the large influx of cold meltwater made April and May water temperatures the coldest in the Snake River in recent years.

Ocean and Climate Conditions

Columbia River Basin salmon and steelhead abundance is strongly correlated with periods of relatively warm or cold off-coast ocean conditions. In general, warmer conditions are less favorable for salmon and colder conditions are more favorable. Pronounced warm and cold cycles have occurred over most of the past century, lasting approximately 20 to 30 years each (Figure 6). This climate pattern is known as the Pacific Decadal Oscillation (PDO).

A cool PDO regime in place from about 1947 to 1976 was characterized by abundant salmon returns to the Columbia River basin. The PDO shifted to a warm phase in about 1977, which coincided with a significant decline in Columbia Basin salmon runs. Although it is not clear yet whether another longer term shift has taken place or what effects might be associated with climate change, ocean conditions have been variable since about 1999, with relatively brief cool and warm periods.[4]

The NOAA Fisheries Northwest Fisheries Science Center (NWFSC) oversees the Ocean Ecosystem Indicators Project to track specific climatic and biological indicators believed to influence the growth and survival of juvenile salmon once they reach the ocean. The NWFSC forecasts coho and Chinook salmon returns based on a survey of several indicators. Ocean

[4] *For more information, see the Pacific Northwest Climate Impacts Group website at http://cses.washington.edu/cig/.*

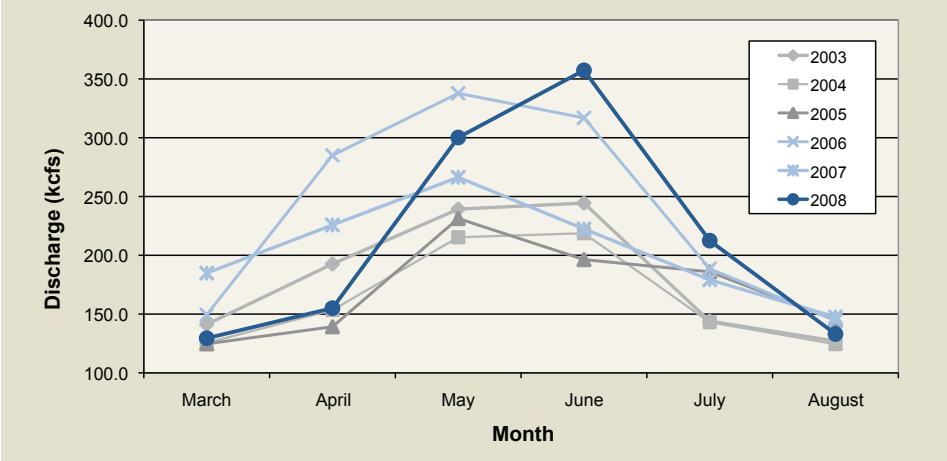

Figure 5. Mean Daily Flow by Month at McNary Dam, 2003-2008.

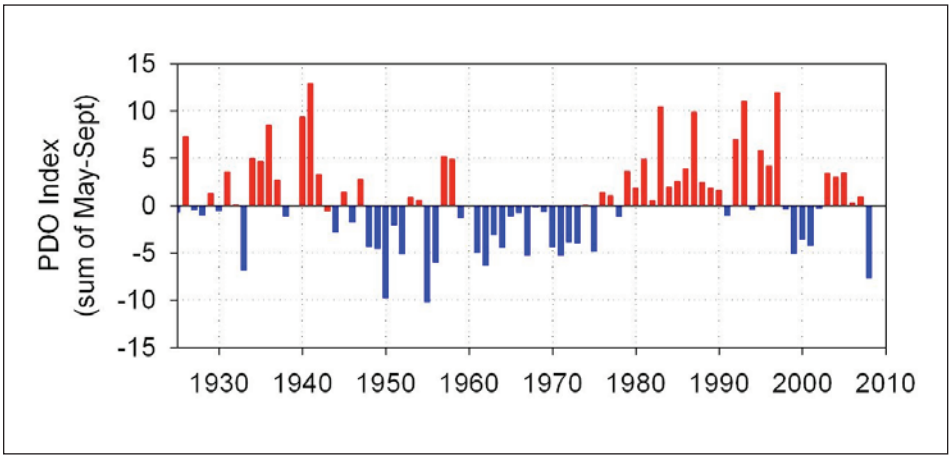

Figure 6. Pacific Decadal Oscillation from 1925 to 2008, Showing Its 20- to-30-Year Cycle and Highly Favorable Conditions in 2008.

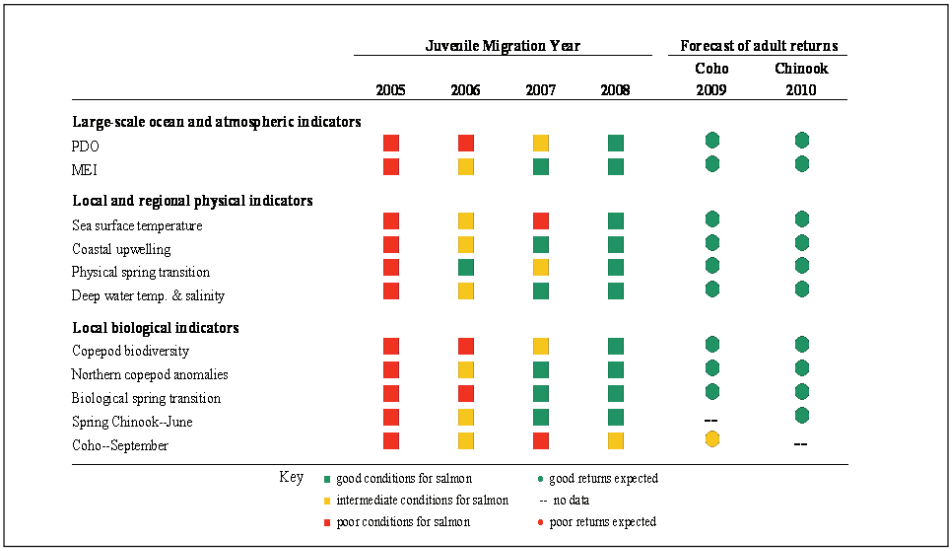

Figure 7. Ocean Ecosystem Indicators of the Northern California Current.

Colored squares indicate positive (green), neutral (yellow), or negative (red) conditions for salmon entering the ocean each year. In the two columns to the far right, colored dots indicate the forecast of adult returns based on ocean conditions in 2008.

ecosystem indicators during juvenile migration year 2008 were the best overall since 1999-2000. As a result, the NWFSC forecasts that spring Chinook runs in 2010 and 2011 should rival the high returns seen in 2001 and 2002, while returns of coho in 2009 should be somewhat lower.[5]

New Climate Change Information

The 2008 BiOp summarized a number of studies, including the Independent Scientific Advisory Board's (ISAB) review of the literature relevant to climate change impacts on Columbia River basin salmon and steelhead (*Climate Change Impacts on Columbia River Basin Fish and Wildlife*, Independent Scientific Advisory Board, 2007). There was no additional significant new information on climate change in 2008. Under the RPA, the Action Agencies provided funding and collaborative support to the Washington Department of Ecology in 2008 to contract with the University of Washington Climate Impact Group to develop climate change streamflow scenarios. The Action Agencies are developing additional data sets, such as climate change water supply forecasts and flood control elevations, that will be used in conjunction with the streamflow scenarios developed by the University of Washington to adequately model climate change impacts to the hydrosystem.

Implementation Overview

The Action Agencies have established implementation strategies and actions using the "All-H" approach—hydropower, habitat, hatchery, and harvest, plus predator management—to work toward salmon and steelhead recovery in the Columbia River basin. Work performed is summarized below. Detailed descriptions can be found in the RPA action implementation portion of this Annual Progress Report.

Hydropower

Under the hydropower strategy, the Action Agencies implemented juvenile and adult dam passage modifications, operation improvements for spill and transport of juvenile fish, water management operations, and operational and maintenance activities aimed at improving juvenile passage survival and adult returns. These actions are focused on achieving higher juvenile dam survival performance standards, as well as the system survival and in-river survival performance metrics.

Improvements for Fish at the Dams

Most salmon and steelhead in the Columbia River basin encounter one or more hydroelectric dams as they migrate to and from the ocean. Fish passage systems provide various routes to help salmon and steelhead get past the dams. Over the past several decades, juvenile fish survival past the dams has improved dramatically.

Juvenile fish migrate past the dams by several routes: through the turbines, through juvenile bypass systems, through spillways, or by collection and transport in barges or trucks. Turbine passage is often considered to be the least desirable juvenile bypass route. As a result, bypass systems, spill, and other passage improvements are used to divert the vast majority of migrating fish past the turbines. Depending on location, time of year, and species, about 76 to 99 percent of the juvenile fish use these non-turbine routes. Juvenile dam survival estimates of 86 to 99 percent[6] have been demonstrated through bypass systems and during spill periods at Snake and Columbia River dams, with survival rates at most of the dams in the upper 90 percent range. The BiOp includes requirements to achieve dam survival performance standards (through all passage routes) of 96 percent for spring migrating fish and 93 percent for summer migrating fish. These standards may have been met at some dams and for some seasons, but significant improvements are also under way. In 2008, the agencies continued to make improvements to fish passage; key accomplishments are noted below.

Spill and Surface Passage

Fish passage through the spill is widely recognized as one important way to get juvenile fish through the dams. Water is "spilled" through spillway openings rather than being routed through turbines to generate power or being used for other purposes. The Action Agencies' hydro operations include spring and summer spill to help juvenile salmon and steelhead pass the lower Columbia and Snake River dams. In 2008, consistent with the court-ordered 2008 Fish Operations Plan, spill levels from 2007 were repeated with only those modifications necessary to accommodate new structures and perform essential research.

Surface passage facilities are increasingly being used in addition to normal spillways to provide more natural river passage conditions, improve juvenile fish survival, reduce fish delay in the forebay, improve water quality, and potentially spill less water. Most juvenile salmon tend to stay in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean. When approaching the dams, juvenile fish need to dive to depths of 50 to 60 feet to find passage routes such as a spillway opening or a screen that will guide them to a juvenile bypass channel. Spillway weirs and the Bonneville corner collector use new technologies to provide more surface-oriented, less stressful passage routes for juvenile fish.

In 2008, two top spillway weirs were installed and tested at John Day Dam, and a removable spillway weir (RSW)

[5] *See the Northwest Fisheries Science Center's Ocean Ecosystems Indicators website at http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm.*

[6] *Generally, juvenile dam survival estimates represent survival of the treatment group relative to the control group.*

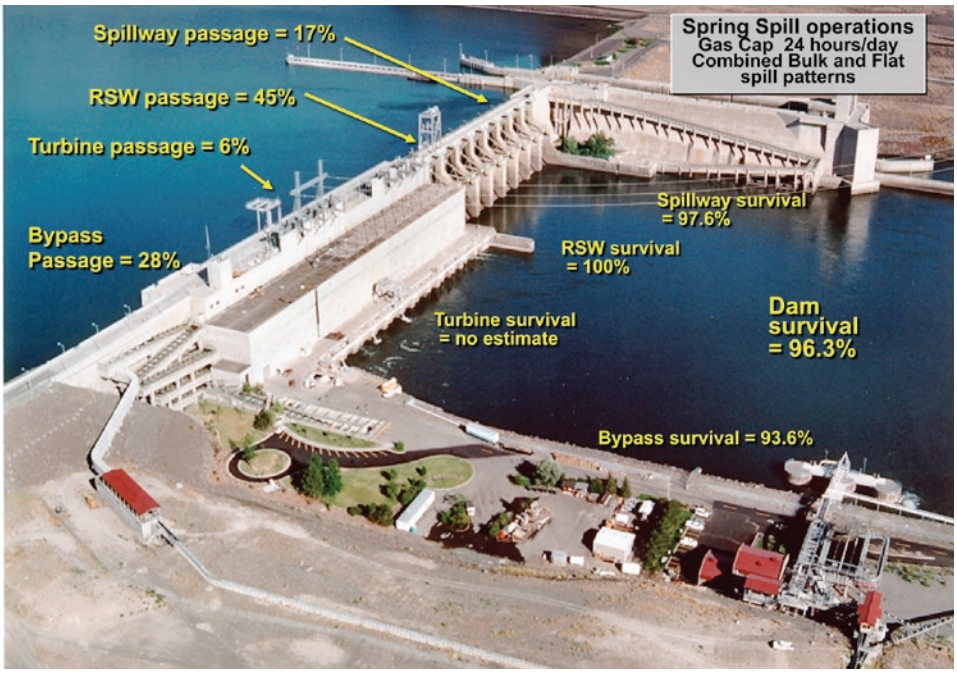

Figure 8. Lower Monumental Dam — Route-Specific Passage and Survival Estimates for Yearling Chinook Salmon When Spring Spillage Operations Are Gas Cap Spill with a Bulk Spill Pattern All Day.

(Source: Passage Behaviour and Survival for Radio-Tagged Yearling Chinook Salmon and Juvenile Steelhead at Lower Monumental and Ice Harbor Dams, 2008 [Preliminary Results], Hockersmith et al. 2008).

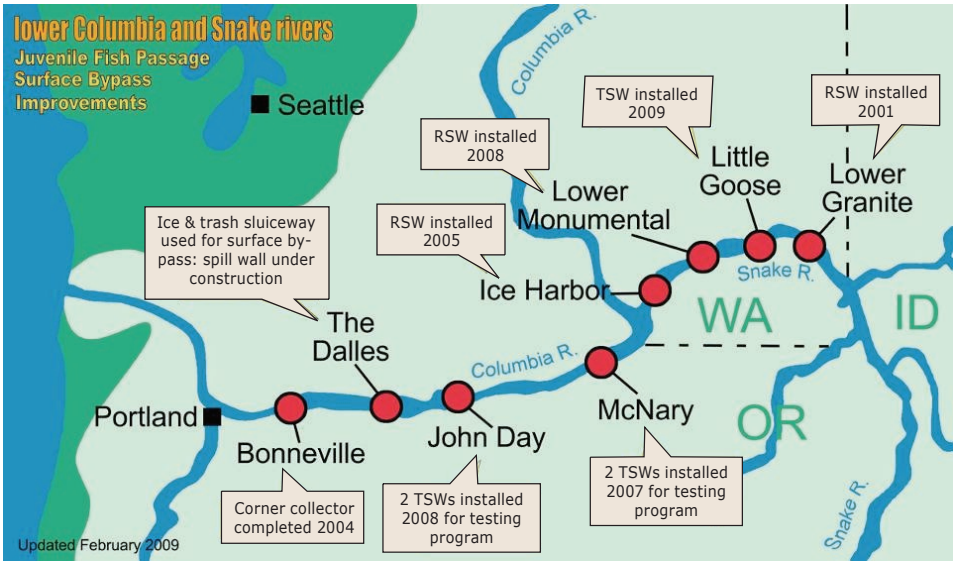

Figure 9. Lower Columbia and Snake River Juvenile Fish Passage Surface Bypass Improvements.

was installed and tested at Lower Monumental Dam. These projects were key milestones in the Action Agencies' commitment to install surface passage and achieve performance standards at all Snake River and Columbia River dams. The John Day facilities reduced salmon and steelhead passage through turbines by 50 percent or more and increased fish survival through the dam. Dam passage survival estimates for yearling Chinook and steelhead were 95.5 percent and 98.4 percent, respectively, while the dam survival estimate for subyearling Chinook was 86.2 percent. The Lower Monumental RSW was very effective for passage and appeared to meet or exceed performance standards. Dam passage survival estimates were 96.9 percent for yearling Chinook (bulk spill pattern), 99.8 percent for steelhead (all spill patterns), and 94.1 percent for subyearling Chinook (bulk spill pattern). Relative survival estimates of fish passing over the RSW were nearly 100 percent for both yearling Chinook and steelhead and 97 percent for subyearling Chinook.

Juvenile Bypass Systems

Juvenile fish bypass systems are in operation at seven of the eight lower Columbia and Snake River dams. Most systems guide fish away from turbines by means of submerged screens installed in front of the turbine intakes. As fish follow currents down toward the turbines, the screens guide the fish back up to channels in the dam. The fish are then either routed to the river below the dam (bypassed) or loaded into barges or trucks for transport past the remaining dams.

In 2008, at Bonneville Second Powerhouse, modifications to the juvenile bypass system were completed to improve fish guidance efficiency. A Little Goose bypass outfall relocation to improve fish survival was initiated in 2008 and is expected to be completed in 2009-2010.

Fish Transportation and Barging

Juvenile fish transportation is an ongoing program that collects fish from facilities at some of the Snake and Columbia River dams, transports them by barge or truck, and releases them below Bonneville Dam. Juvenile fish are collected at Lower Granite, Little Goose, and Lower Monumental dams on the Snake River and occasionally at McNary Dam on the lower Columbia.

The timing and conditions for fish transportation are determined based on annual research comparing adult returns to the spawning grounds of transported fish versus fish that migrated in river. In general, fish survive better migrating in river in early April but survive better with transport in lower water conditions during mid- to late May. Also, steelhead generally experience higher survival through transportation than do Chinook salmon

during the spring migration. The Action Agencies shift to transportation in the Snake River when river flows are low.

In 2008, transportation began on a staggered basis in the Snake River collector projects beginning in May and at McNary Dam beginning in late July. Approximately 14.46 million of the migrating juvenile salmon and steelhead were collected at transport locations in 2008. Approximately 36 percent of collected fish were returned to the river. As a result, about 52.5 percent of the total number of juveniles migrated in river, with the remainder being transported (Figure 10).

Based on passive integrated transponder (PIT) tag data and preliminary results, NOAA Fisheries estimated that 54.3 percent of wild Snake River yearling Chinook and 45.3 percent of hatchery Snake River yearling Chinook were transported in 2008, while 50.5 percent of wild Snake River steelhead and 46.6 percent of hatchery Snake River steelhead were transported that year. Of the fish transported, almost 99 percent were transported by barge and just over 1 percent were trucked.

Water Management and Flow Operations

In addition to fish passage at the dams, operators control storage reservoirs to enhance fish survival. They augment river flows with water released from upstream dams to help juvenile migration and adult spawning, and to cool water temperatures.

Water management actions recognize that available storage—water that actually can be managed—is limited relative to total annual runoff in the Columbia River Basin. Specific operating rules, including earmarking amounts of water for fish flows, are used at individual reservoirs to provide salmon flows, protect resident fish, control floods, and serve other authorized purposes.

In 2008, the Action Agencies developed an annual Water Management Plan that incorporates the operating rules from the BiOp. Both the storage projects and the run-of-river mainstem lower Columbia River and Snake River projects were operated under the plan to aid juvenile fish passage. (Storage projects are the Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak projects, while the run-of-river projects are Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite.)

The Action Agencies coordinated with Canada and entered into an agreement on operation of treaty storage for non-power uses for the period December 15, 2007, through July 31, 2008. Under this agreement, 1 million acre-feet (MAF) of flow augmentation water was stored in Mica Reservoir during January and early February 2008. All flow augmentation storage was released by June 30, 2008, under this agreement. The Action Agencies stored 52 thousand acre-feet (kaf) into non-treaty storage in September 2008, bringing the U.S. account to 73 percent of full on September 30, 2008.

In 2008 the Bureau of Reclamation provided 487 kaf of flow augmentation water from the upper Snake River above Brownlee Reservoir in accordance with the National Marine Fisheries Service's 2005 Upper Snake BiOp. For more information see the December 12, 2008, Annual Progress Report for Reclamation's 2008 Salmon Flow Augmentation Program.[7]

Water Quality

The Action Agencies monitor water quality to measure temperature and dissolved gas in the river. When providing spill for fish passage, dam operators direct some water through the spillways instead sending all of it through the turbines. At large dams, spilled water plunges to the river below the dam with enough force to supersaturate atmospheric gases in the water. These gases can build up to levels that are dangerous to salmon and other aquatic life. To address this, the agencies monitor total dissolved gas (TDG) levels in the river and adjust patterns and quantities of spill to stay within acceptable levels. In 2008, there were 93 gauge-day exceedances of state TDG standards associated with voluntary spill for fish. There were 422 gauge-day instances in which TDG levels were higher than state

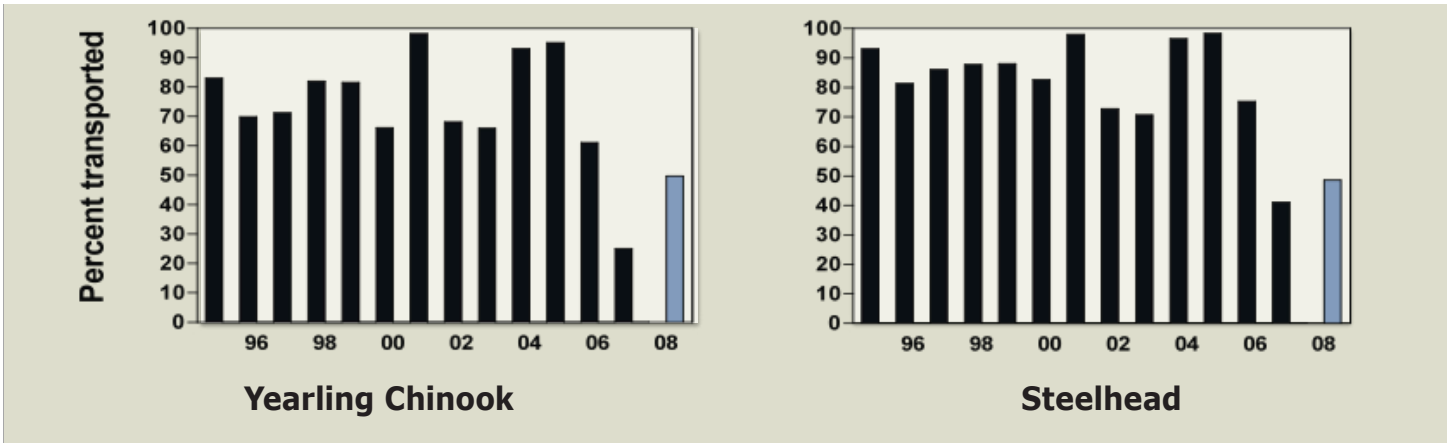

Figure 10: Percentage of Fish Transported to Below Bonneville Dam.

[7] *Annual Progress Report: Bureau of Reclamation 2008 Salmon Flow Augmentation Program and Other Activities Associated with the National Marine Fisheries Service 2005 Biological Opinion and Incidental Take Statement for Operation and Maintenance of Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir, December 12, 2008, United States Department of Interior, Bureau or Reclamation, Pacific Northwest Region, Snake River Area.*

standards as a result of (1) high river flows that forced involuntary spill, (2) turbine unit outage, or (3) high TDG levels upstream.

To help cool the lower Snake River in the summer, cold water is released from Dworshak Dam on the Clearwater River from early July through mid-September. The benefit of these cold-water releases was apparent as the agencies monitored temperatures in the Snake River, at Lower Granite Dam: temperatures there were consistent with state standards for the entire season. For a more thorough discussion of how the system was operated in 2008, see the annual "TDG and Temperature Report" links at *http://www.nwd-wc.usace.army.mil/TMT/wqwebpage/mainpage.htm*.

Kelt Management

Several actions taken in 2008 were designed to enable development of a Kelt Management Plan for Snake River steelhead in 2009. Preliminary plans were developed for kelt collection activities at the juvenile fish facility and potential reconditioning efforts at the Dworshak Fish Hatchery in 2009. Federal, tribal, and University of Idaho representatives met and identified Lower Granite as the primary collection point for this work. The objective of this unique program is to increase survival and productivity of mature steelhead, such as by holding them and allowing them to spawn again the following year.

With funding from BPA, the Columbia River Inter-Tribal Fish Commission (CRITFC) began work on a Kelt Master Plan for Snake River fish, to provide more detail on the reconditioning aspect of the broader Kelt Management Plan at various locations. Implementing the master plan will include a three-step science and technical review process undertaken by the Northwest Power and Conservation Council.

Predator Management

Four main predators consume large numbers of juvenile salmon and are a major cause of mortality of ESA-listed fish in the Columbia River system. Caspian terns and double-crested cormorants, which eat large numbers of migrating fish, have enjoyed population increases over the last two decades in the Columbia River estuary and are also present in the mid-Columbia region. Among fish, northern pikeminnow are voracious consumers of juvenile salmon and steelhead. California sea lions are known to consume substantial numbers of adult Chinook salmon and steelhead below Bonneville Dam.

Federal and state agencies are cooperating in efforts to reduce predation on listed species. Programs to redistribute Caspian terns in the estuary, deter and block sea lions from Bonneville Dam fish ladders, and reduce the northern pikeminnow population through a sport-reward program have been successful in reducing the loss of adult and juvenile salmon to predation. In 2008, the Action Agencies continued efforts to control specific predators and improve survival of juvenile fish.

Caspian Terns and Double-Crested Cormorants

Caspian terns and double-crested cormorants consume large numbers of juvenile salmon and steelhead. Together, the terns and cormorants consumed an estimated 15.9 million juvenile salmon in the estuary in 2008. The federal agencies have been addressing growing populations of Caspian terns and double-crested cormorants nesting in the estuary as well as Caspian terns and double-crested cormorants in the Mid-Columbia River that prey on juvenile salmon.

Caspian terns nesting on East Sand Island consumed approximately 6.7 million young salmon in 2008, compared to the estimated 15 million they consumed in 1999.

Recent efforts to redistribute Caspian terns from Rice Island, in the Columbia River estuary, to East Sand Island, nearer to the ocean, were successful in reducing predation rates As intended, the relocation shifted the terns' diets away from juvenile salmon toward a more diverse diet of predominantly marine fish species. (At Rice Island, juvenile salmon made up 75 to 90 percent of the terns' diet.)

In 2008, the East Sand Island tern colony consumed approximately 6.7 million juvenile salmon (*http://www.birdresearchnw.org/CEDocuments/Downloads_GetFile.aspx?id=349567&fd=0*). In comparison, in 1999, the colony consumed about 15 million salmon when located at Rice Island. Approximately 10,700 pairs of Caspian terns nested on East Sand Island in 2008, which is an increase from the estimated 9,900 pairs that nested on the island in 2007. Plans are under way to relocate two-thirds of the Caspian terns to alternate nesting sites in Oregon and California (see *http://www.nwp.usace.army.mil/pm/e/en_plan_avian.asp*).

In the early spring of 2008, the U.S. Army Corps of Engineers began carrying out the Caspian Tern Management Plan with the construction of two islands for tern relocation—one in Fern Ridge Reservoir, near Eugene, Oregon, and the other in Crump Lake in southern Oregon. Although terns were slow to respond to the newly created island at Fern Ridge Reservoir, the opposite was true of the island constructed at Crump Lake. Construction of alternate habitat continued after the 2008 breeding season with the first of three islands in Oregon's Summer Lake State Wildlife Area, which was completed in December. Another island in Summer Lake will be constructed before the 2009 breeding season. At all of the islands constructed or enhanced through the tern management plan, social attraction, tern decoys, and tern colony sounds will be used in the spring of 2009 to attract terns.

The agencies also are considering management actions to address a greatly increased population of double-crested cormorants in the Columbia River estuary. The cormorant nesting population on East Sand Island increased from around 100 pairs in 1989 to about 13,771 breeding pairs in 2007. The number of juvenile fish consumed by cormorants averaged 6.8 million fish for 2003-2007, with 2.9 to

10 million juveniles being consumed per year. Estimates of cormorant consumption of salmon for 2008 are still being developed.

In 2008, the Action Agencies continued a study of potential management techniques for reducing losses of juvenile salmon to cormorant predation in the Columbia River estuary. This study sought to determine whether habitat enhancement and social attraction techniques can be used to induce double-crested cormorants to nest in an area outside the Columbia River estuary where they have not previously nested. In 2008, the agencies continued employing habitat enhancement (such as placement of old tires filled with nesting material) and social attraction techniques on a floating platform in Fern Ridge Reservoir in an effort to attract cormorants away from the estuary.

Northern Pikeminnow

Northern pikeminnow are voracious consumers of juvenile salmon. Since 1990 BPA has funded the Northern Pikeminnow Management Program (NPMP) to reduce the numbers of larger pikeminnow and improve survival of juvenile salmon. In 2008, the BPA reward for the catch of this predator was sustained at a higher tiered monetary level initiated in 2005. This reward structure helps sustain the higher catches and resulted in the highest harvest rate of pikeminnow since program inception.

Northern Pikeminnow, a Voracious Consumer of Juvenile Salmon

In 2008, the pikeminnow program continued implementation of its base reward program, which relies on private-sector fishing efforts to provide the majority of the catch of northern pikeminnow. In addition, program managers reinstated a dam-angling program component for the first time since 2001. This program provided two fishing crews that focused on the forebay and tailrace sections of the Bonneville and The Dalles dams—areas not accessible to the general fishing public. Also in 2008, evaluation crews were able to tag 70 percent more pikeminnow than in 2007, to better evaluate the benefits of predator management. The Northern Pikeminnow Management Program has removed more than 3.3 million pikeminnow from the Columbia River since 1990. Evaluation indicates that, as a result, pikeminnow predation on juvenile salmon has declined 38 percent since that time, saving 4 to 6 million juvenile salmon annually that would otherwise have been eaten by this predator.

California Sea Lions at Bonneville Dam

In recent years, California sea lions, which are protected under the Marine Mammal Protection Act (MMPA), have been observed swimming more than 140 miles up the Columbia River to Bonneville Dam to prey on adult Chinook salmon, steelhead, and sturgeon. Generally arriving from mid- to late February and leaving by the first week in June, these male sea lions eat to gain weight in preparation for the summer mating season.

Corps biologists began gathering data on sea lion presence and predation at the dam in 2001, when six California sea lions were documented. In 2002—the first full season of monitoring—30 sea lions were counted. In 2004, 101 sea lions were counted, and in 2005 the number was estimated at 87 or more. From 2006 to 2008 the number increased from 72 to 84. Not all of these were at the dam at the same time; usually about 30 were present on any one day. The amount of fish eaten by sea lions has increased every year. In 2002 the expanded catch estimate was 1,010 adult salmon and steelhead that passed Bonneville Dam from January 1 through May 31. In 2008 the expanded catch estimate was 4,466 adult salmon and steelhead (Figure 11). For more information, see *http://www.nwd-wc.usace.army.mil/tmt/documents/fish/2008_Pinniped_Report.pdf*.

The Corps implemented and evaluated a variety of sea lion deterrents, from physical barriers to non-lethal harassment, in 2008. Sea lion exclusion devices were installed at Bonneville Dam's 12 primary fishway entrances to prevent sea lions from entering the fishways. Corps biologists also coordinated with U.S. Department of Agriculture personnel and boat-based crews from the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and CRITFC on all sea lion harassment activities at Bonneville Dam. In addition, the Action Agencies supported CRITFC in conducting monitoring and non-lethal harassment efforts to deter marine mammal predation downstream of the dam.

A California sea lion catches a steelhead at Bonneville Dam.

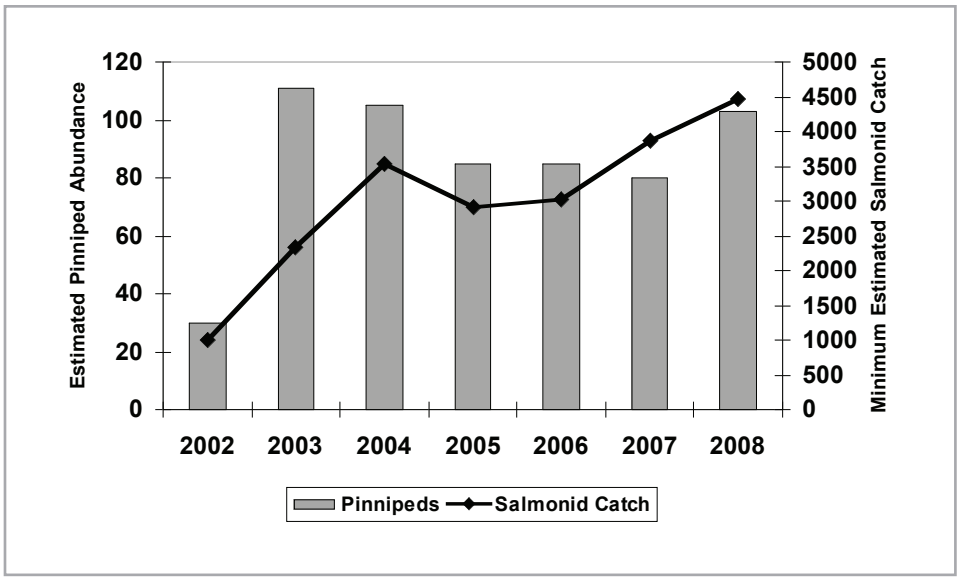

Figure 11. Estimated Minimum Number of Adult Salmonids Consumed by Pinnipeds and Estimated Total Number of Pinnipeds Seen at Bonneville Dam January 1–May 31, from 2002 to 2008.

In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals.

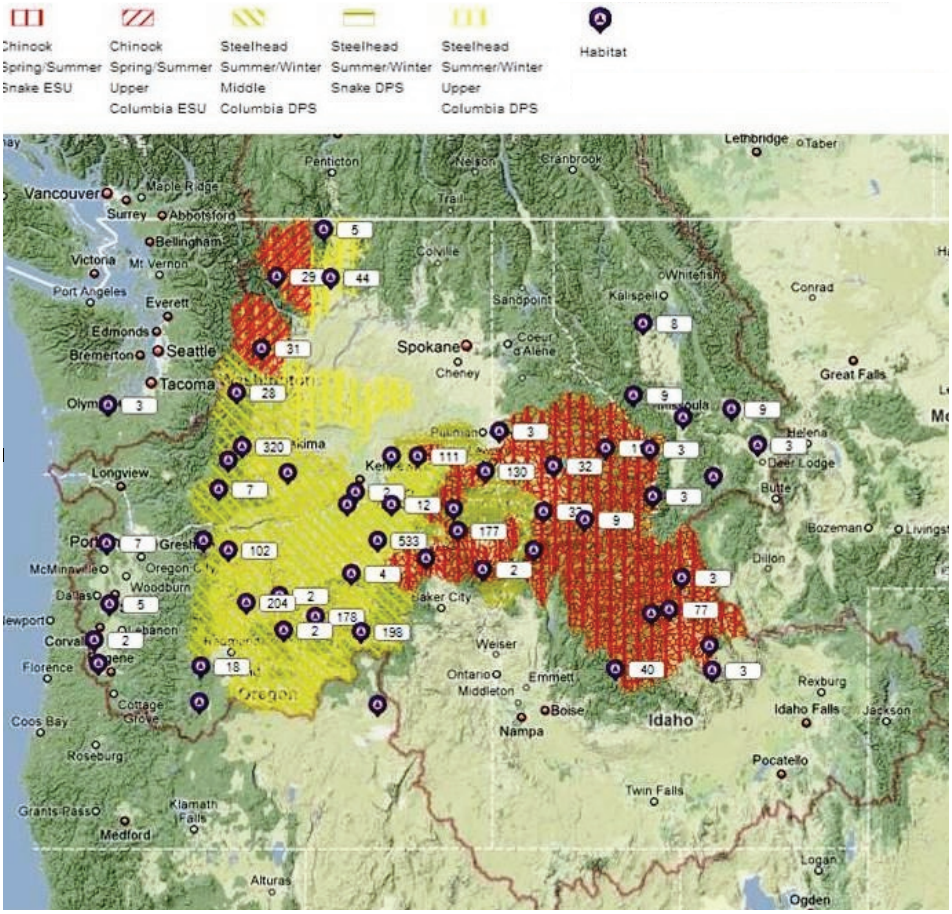

Figure 12. Action Agency Funded Tributary Habitat Projects, 2005 - 2008.

In 2008, under the MMPA nuisance sea lion removal authority, the states trapped 11 California sea lions. Six were sent to aquariums, four were processed (measured, weighed, and marked with a three-digit brand) and released, and one died under anesthesia before it could be sent to an aquarium. In May 2008, four California sea lions and two Steller sea lions died on traps, halting trapping operations for the 2008 season.

Habitat Protection and Improvement Actions

Columbia River estuary and tributary habitat is important to salmon in their complex life cycle. Each year, the Action Agencies spend tens of millions of dollars under the RPA and the Columbia Basin Fish Accords to implement actions that improve the quantity and quality of habitat used by salmon in the estuary and tributaries. In coordination and partnership with other federal, state, and local parties, the Action Agencies are increasing the volume of water in streams, installing or retrofitting fish screens at water diversions to keep fish safely out of irrigation canals, reconnecting side channels and floodplains to add complex and diverse habitats, removing barriers to fish passage, and acquiring easements or other protective interests for riparian areas along tributaries.

Tributary Habitat

In 2008, the Action Agencies began to expand an already significant tributary habitat program and took steps to target key factors known to limit the survival of specific salmon and steelhead populations. This effort improves on past BiOps. Not only does the expanded program use up-to-date biological information to target habitat actions to fish populations with the greatest biological need, but it also by uses local expert panels to identify and prioritize the most biologically appropriate actions for those populations. In addition to these population-focused efforts, the Action Agencies maintained or expanded their current overall level of effort for other anadromous fish populations. Specific projects have already been identified for implementation through 2009.

Specific tributary habitat projects for 2010-2012 are now being identified using recovery plan information and the BiOp's "expert panel" process, which is driven by local experts who identify tributary habitat projects and assess their biological benefits. Expert panel members include representatives from NOAA Fisheries, tribal and state fish and wildlife agencies, the U.S. Forest Service, local watershed groups, conservation districts, and recovery boards. The expert panels will be convened in 2009 and subsequently on a 3-year cycle for the duration of the BiOp, to review accomplishments and associated biological benefits during the last 3-year cycle, incorporate new scientific information (including climate change data), and identify actions and estimate associated biological benefits for the next 3-year cycle.

Projects to protect, improve, or restore critical fish habitat employ different approaches targeted to the specific limiting factors found in the individual watershed. The following sections summarize Action Agency accomplishments from 2005 to 2008 and provide examples of the work completed in 2008.

Increasing Water Quantity and Quality through Water Transactions

Fish survival can suffer from the combined effect of naturally low summer flows and water withdrawals for human uses. One of the most effective and immediate steps the Action Agencies may take to improve fish habitat is to lease or purchase water rights or install water efficiency improvements to increase the amount of water in streams. This in turn provides immediate improvements to salmon and steelhead survival by reducing thermal stress and providing higher quality habitat for spawning and juvenile rearing. Since 2005, the Action Agencies acquired instream water to conserve or protect almost 200,000 acre-feet and 1,000 cubic feet per second (cfs) of water.

Tributary Habitat Accomplishments

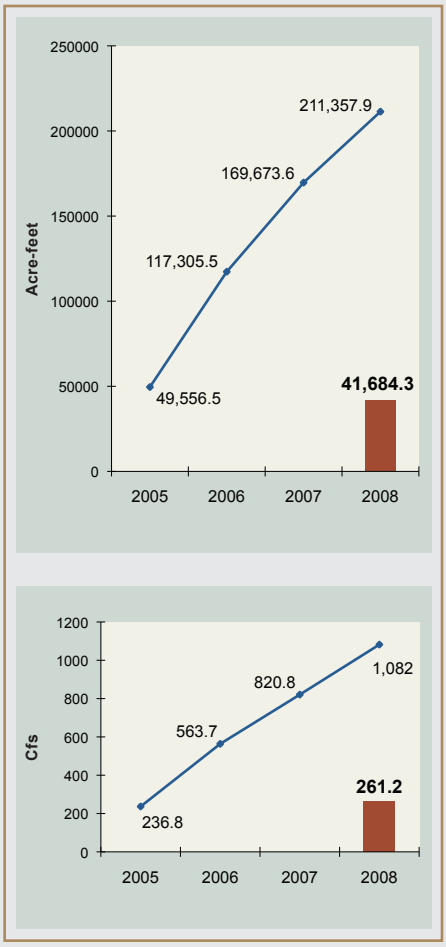

Figure 13. Water Protected, 2005 – 2008, in Acre-feet and Cfs.

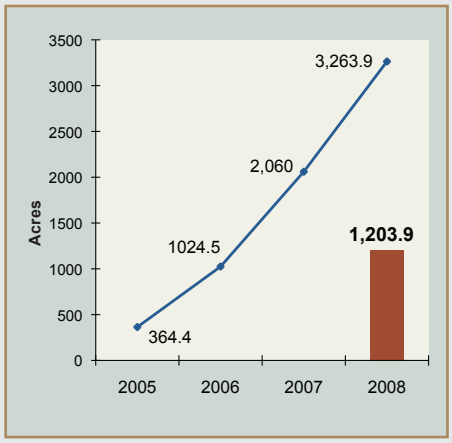

Figure 15. Acres Improved, 2005 – 2008.

Improvement measures included creating, connecting, or realigning channels; conducting controlled burns; planting; practicing no-till farming; removing mine tailings and invasive plant species; enhancing floodplains; or restoring wetlands.

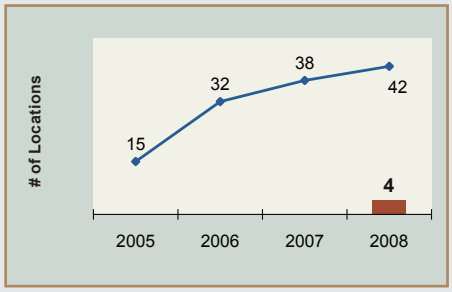

Figure 16. Number of Locations Where Entrainment Was Addressed, 2005 - 2008.

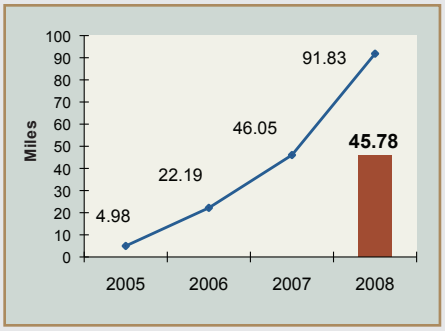

Figure 14. Miles of Improved Stream Complexity.

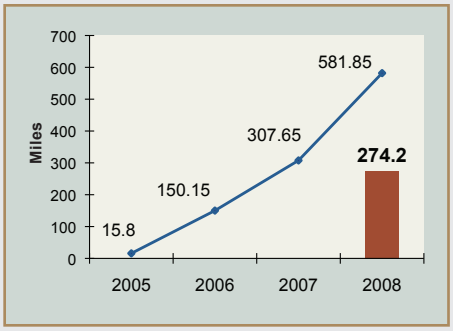

Figure 17. Improved Access to Habitat, 2005 - 2008.

Cumulative annual results

2008 amount

Source: See Habitat Metrics by Fiscal Year report available at http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx (limited to subbasins with anadromous fish).

An example of this approach took place in the Pahsimeroi River basin in central Idaho. Historically, central Idaho's Pahsimeroi River, a tributary of the Salmon River, coiled through a basin with abundant spawning and rearing habitat for summer Chinook salmon, steelhead, and westslope cutthroat trout. But for more than a century, parts of the Pahsimeroi and its tributaries have run dry in late summer and early fall because of water diversions for irrigated agriculture.

In 2008, BPA funded the Idaho Department of Water Resources (IDWR) to complete 20-year agreements that re-opened 10 miles of high-quality, spring-fed creek habitat previously impassable to fish. Agreements with four landowners restored stream flows though a series of complex arrangements. As part of the project, the landowners also are switching from flood irrigation to more efficient sprinkler systems. The project restores nearly 30 cfs—more than 13,000 gallons per minute—of clean, cold water from April 1 to October 31, a flow-limited period for fish. State biologists report that adult salmon are already returning to this newly available habitat.

Improving Habitat Complexity

Salmon evolved in streams that meandered, created multiple channels, and flooded seasonally. The complex habitats these processes created provided important rearing areas for juvenile salmon and steelhead, as well as cool-water refuges during the heat of summer. Human development has changed the nature of most of the Columbia River basin's river systems, depriving salmon of some of these habitat attributes.

An important component of the Action Agencies' habitat program involves funding actions and providing technical assistance to improve channel complexity by reconnecting side channels and, where feasible, increasing floodplain function to improve instream habitat conditions. The Action Agencies have improved 100 miles of stream since 2005, with 46 miles completed in 2008.

One example of this type of work involved the construction of approximately 200 feet of meandering channel habitat in the Chewuch River where the river channel had been cleared after extensive flooding in the middle of the 20th century. Although the clearing effectively reduced flood threats, it also disconnected off-channel rearing habitat and floodplains that are important for fish. Through a contract with BPA, the Methow Salmon Recovery Foundation removed fill material to allow more water to flow from the Chewuch River into a disconnected side channel and constructed controls at an irrigation diversion point to provide continuous streamflow into the new side channel. This project provides more complex and diverse rearing habitat for Upper Columbia spring/summer Chinook and steelhead.

Improving and Protecting Riparian Areas to Improve Water Quality

Riparian habitat—the streamside environment—makes a major contribution to water quality and long-term salmon survival. Although actions to improve and restore degraded riparian habitat can take years to yield results, they are nonetheless an essential salmon improvement strategy element. Because these actions can help moderate stream temperatures, they are an important hedge against the longer term effects of climate change, which are expected to cause stream temperatures to increase seasonally throughout the Columbia River Basin.

Riparian habitat can be protected through land purchases or conservation easements, which aim to reduce adverse land use impacts. In many instances, plantings or natural revegetation can reestablish a viable riparian zone by providing shade and other benefits for the stream. Since 2005, the Action Agencies have improved more than 3,000 acres (see Figure 15) and protected more than 37,000 acres. In 2008, BPA funded projects to improve and protect more than 1,100 acres of riparian vegetation, lease or purchase more than 9,800 acres of riparian habitat, secure more than 15,000 acre-feet of water, install 34 miles of riparian fencing, and improve or relocate more than 11 miles of roads affecting riparian areas. These projects are expected to provide habitat benefits that will help keep water cool and clean for ESA-listed populations.

Adult salmon responded by returning to the Pashsimeroi River and its tributaries where water was leased from farmers and ranchers in 2008.

For example, in 2008, BPA funds were used to extend land leases in the Tucannon watershed under the Conservation Reserve Enhancement Program (a voluntary agricultural land retirement program), ensuring continued protection of more than 350 acres of riparian habitat. As the riparian vegetation from these projects matures over time, it will help shade and cool the stream water and provide opportunities for recruitment of the large woody debris needed for complex habitat.

Reducing Fish Entrainment at Irrigation Diversions

The Action Agencies have been funding projects to replace, improve, and install fish screens at irrigation diversions to prevent fish from becoming trapped, or entrained, in irrigation ditches. The fish screens, which are designed according to state and federal criteria, keep fish in the streams—out of irrigated fields—and thus provide immediate improvements to juvenile fish survival. Fish screen projects also helped consolidate irrigation diversions and replace instream diversions with groundwater wells, so that water can be diverted for irrigation but the need for an associated fish screen is reduced or eliminated entirely. Since 2005, the Action Agencies have addressed fish entrainment at 42 locations, four of those in 2008.

In 2008, one of these projects involved the installation of an improved fish screen at a pump station that for many years has diverted water for irrigation from a side channel of the Wenatchee River in Washington State. A fish screen was in place at the pump site to prevent fish that use the side channel habitat (for rearing and to evade predators) from being drawn into the pump. But the screen no longer functioned as intended. Washington Department of Fish and Wildlife worked with the landowner to upgrade the screen to meet current criteria. Reclamation designed a vertical flat-plate screen for the pump station that was constructed and installed in 2008. The screen was specifically designed to have as little impact as possible on the side channel's depth and velocity, which are attractive to fish. A mechanical brush sweeps across the length of the screen to prevent accumulation of debris and maintain optimum screen function.

Improving Access to Spawning and Rearing Habitat

Human development has restricted access to significant portions of the historical range of Columbia River basin salmon and steelhead in many Columbia River tributaries. Many of these blockages can be fixed with negligible economic impact, providing a big biological boost to fish. Since 2005, the Action Agencies have improved access to more than 580 miles of instream habitat for anadromous fish (see Figure 17).

In 2008, the Action Agencies funded projects that opened up more than 260 miles of fish habitat. One such project took place in Idaho's Clearwater National Forest on the North Fork Spruce Creek, a tributary of the Lochsa River. A bridge with abutments that limited fish passage into good-quality habitat was replaced with a wider span bridge that allows a more free-flowing and natural stream channel. This project, funded by BPA and the U.S. Forest Service, was implemented through contracts with the Nez Perce Tribe and provided access to 3 miles of habitat for all life stages of fish.

Estuary Habitat Actions

Fish from throughout the Columbia River basin use the Columbia River estuary for varying amounts of time during all months of the year. The estuary's diverse

Wenatchee River (Before).
The leaky fish screen at the pump station did not meet current criteria for protecting salmon and steelhead that use the side channel habitat.

Wenatchee River (After).
The design of the new fish screen maintains beneficial velocity and depth characteristics that attract juvenile fish into the rearing habitat in other parts of the side channel.

habitats provide food and refuge for juvenile salmon for rearing and migrating as they make their critical transition from fresh water to salt water. Adult salmon returning to the Columbia River also must pass through the estuary.

In 2008 the Action Agencies expanded funding to implement on-the-ground projects to address biological priorities and key factors that limit fish survival in the estuary. Project types include the protection of remaining high-quality, off-channel habitats, reduction of invasive plants, and protection and restoration of riparian and wetland areas. In 2008, the Action Agencies completed eight on-the-ground habitat projects in the estuary, with another three projects in the planning and development phase.

One of the estuary habitat projects implemented by the Action Agencies in 2008 is the Willow Grove Acquisition and Restoration Project, which permanently protects 304 acres of intertidal wetland habitat adjacent to the Columbia River just downstream of Longview, Washington. The Willow Grove property has been altered by past land uses but represents an example of critical intertidal wetlands within this reach of the Columbia River. The wetlands provide important rearing habitat for juvenile salmon, particularly in this portion of the river where much of the historical floodplain and off-channel areas have been altered by industrial and commercial development.

Long-term management of the site includes implementing a management plan, to maintain and restore important habitat, and conducting regular monitoring as part of an adaptive management program. Future actions may include vegetation enhancement, control of invasive species, placement of large wood material, and enhancing fish access to the wetland complex from the mainstem Columbia River. This acquisition and restoration project provides benefits to multiple species of anadromous salmon, including Chinook, chum, coho, and steelhead.

In 2008 the Action Agencies also initiated implementation of a new Pile Structure Program. In collaboration with the Lower Columbia River Estuary Partnership (LCREP) and others, the Action Agencies completed a final draft program plan for the new program and established a technical subcommittee under the Estuary Partnership's Science Work Group. Efforts to implement the Pile Structure Program included gathering pile structure site condition data, designing a scientific approach, and preparing the final draft of the Pile Structure Program Plan.

North Fork Spruce Creek Bridge Passage Barrier (Before).
Bridge abutments narrow the stream channel and restrict access to upstream habitat.

North Fork Spruce Creek Bridge (After Replacement).
The new 60-foot-long bridge has abutments placed well outside the active stream channel.

Willow Grove Acquisition and Restoration on the Columbia River, near Longview, Washington (facing east from Willow Grove Road, toward the northwest portion of the site).

Pilings and pile dike were identified as one of many threats to juvenile salmon in NOAA Fisheries' *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead*. The module states that extensive use of pile structures has resulted in the following limiting factors: impaired sediment accretion and erosion processes; reduced flow circulation through shallow-water habitats; creation of favorable conditions for predators of salmon and steelhead, such as pikeminnow and cormorants; reductions in physical access to low-velocity juvenile salmon habitats that are important for refuge and feeding; and, in those cases where pile structures have been treated with harmful wood preservatives such as creosote, the release of toxic contaminants, including polycyclic aromatic hydrocarbons (PAHs), into the water column and sediment.

Table 2 summarizes the estuary habitat metrics accomplished in 2008 with Action Agency funding assistance.

Table 2. Summary of Estuary Habitat Metrics, 2008.

Action	Metric
Improve and Restore Streams/Channels	6 linear miles
Restore Floodplain	60 acres
Plant/Maintain Native Vegetation	285 acres
Remove Invasive Plant Species	303 acres
Restore Riparian Areas	57 acres
Install Fence in Riparian Area	5 miles
Land Acquisition *(Future restoration actions will be implemented on land acquisitions.)*	380 acres

Projects for future implementation are now being identified using emerging tools such as the Ecosystem Classification System. The Ecosystem Classification System, which is being developed specifically for the estuary, will help local experts, planners, and project managers strategically identify and select restoration and protection projects that provide the highest benefits for the 13 listed ESUs in the Columbia River.

Hatchery Management Actions

The Action Agencies continue to fund an extensive existing hatchery program as offsite mitigation for the federal dams, including conservation hatcheries for listed fish, while preparing for scientifically based hatchery reforms throughout the Columbia River basin. In 2008, the Action Agencies developed criteria for future hatchery funding decisions that require hatchery programs to operate in accordance with ESA requirements and, to the maximum extent practicable, operate in accordance with best management practices (BMPs) applicable to the individual program defined in program-specific ESA consultations. BPA funded the Hatchery Scientific Review Group (HSRG) process in 2008 to enable the HSRG to complete its comprehensive review and analysis of all Columbia Basin hatchery programs and prepare its final report with recommendations for hatchery reform. The Action Agencies' strategy is to ensure that FCRPS mitigation hatchery programs are not impeding recovery of salmon ESUs or steelhead DPSs by reforming hatchery operations to reduce the genetic and ecological effects on ESA-listed salmon and steelhead.

BPA and Lower Snake River Compensation Program (LSRCP) staff initiated planning for specific hatchery reform actions to transition the Tucannon River and Touchet River steelhead hatchery programs from Lyons Ferry Hatchery broodstock to local broodstock. The Winthrop National Fish Hatchery initiated a pilot program to evaluate longer-term rearing of juvenile steelhead that would be required to transition to a locally adapted steelhead broodstock in the Methow River —a key initiative aimed at addressing one of the factors limiting the productivity of this Upper Columbia steelhead population.

The Action Agencies also continued to fund safety-net programs to reduce the extinction risk of at-risk populations of ESA-listed Snake River sockeye salmon and Snake River spring/summer Chinook. One of those programs, the Snake River Sockeye Salmon Captive Broodstock Program, preserves this critically imperiled

Figure 18. **Anadromous Fish Hatcheries Funded by the Action Agencies, Including Anadromous/Resident Fish Safety-Net Hatcheries.**

species. The program has produced hundreds of thousands of progeny from remnants of the wild stock. The progeny are raised in carefully managed hatcheries and released into their natural habitats to spawn or migrate downstream. Since 1999, 1,005 adults from the program have returned to Redfish Lake. The year 2008 was a particularly good return year, with 650 adult sockeye salmon returning to the Stanley Basin. This is the largest recorded annual return since 1956.

On September 2, 2008, a new state-of-the-art fish hatchery building was dedicated at the Idaho Department of Fish and Game's (IDFG) Eagle Fish Hatchery. This is one of three related efforts to increase sockeye salmon smolt production to 150,000 sockeye salmon smolts—an initial step toward a goal of producing 500,000 to 1 million sockeye salmon smolts. The expanded hatchery capacity will accommodate additional sockeye salmon broodstock holding, adult spawning, egg incubation, and juvenile rearing.

On May 2, 2008, the Action Agencies signed a fish accord with Idaho that commits the agencies to providing funding for a new sockeye salmon fish hatchery (property acquisition and construction). Throughout 2008, BPA worked with IDFG to identify and begin the acquisition process for property meeting the criteria for a facility that will ensure propagation of up to 1 million sockeye salmon smolts.

The Action Agencies continued to fund hatchery conservation programs for Upper Columbia, Mid-Columbia, and Snake River steelhead to preserve and rebuild genetic resources and assist in promoting recovery of these ESUs. During 2008, BPA technical staff reviewed proposals and assisted with development of two new projects—one to recondition Upper Columbia River steelhead kelts and increase spawner abundance of this endangered DPS, and another project aimed at reintroducing Columbia River chum salmon in lower Columbia River tributaries below Bonneville Dam and increasing the abundance of this threatened ESU.

Harvest

The overall harvest objective for all ESUs is to improve adult life-stage survival. Harvest of ESA-listed fish species in the Columbia River basin is managed primarily through state and federal agencies—other than the Action Agencies—and tribes. However, the Action Agencies have supported the identification and implementation of approaches or conservation measures to reduce the effects of harvest on ESA-listed species. In 2008, the Action Agencies funded the initial evaluation of several types of live-capture fishing gear that can be used to selectively harvest marked hatchery fish while allowing ESA-listed wild fish to escape unharmed.

Research, Monitoring, and Evaluation

The Action Agencies implement an extensive research, monitoring, and evaluation (RME) program that focuses on maximizing performance of management actions. The RME program is implemented through the Northwest Power and Conservation Council's Fish and Wildlife Program, the Corps' Anadromous Fish Evaluation Program, and Reclamation's technical assistance activities, and it is coordinated with RME activities of other regional agencies. The Action Agencies work closely with the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) – a forum for coordinating state, federal, and tribal aquatic habitat and ESA-listed salmon and steelhead monitoring programs to collaboratively advance a regionally coordinated approach to fish and habitat monitoring, action effectiveness research, and data management.

In 2008, programmatic performance was tracked through project implementation and compliance monitoring, while biological and environmental performance was tracked and evaluated through status monitoring, action effectiveness research, and critical uncertainty research. Performance standards were monitored to ensure accountability and adherence to proposed actions.

Adult Salmon Staging Prior to Spawning.

The Action Agencies implemented RME projects within nine strategic areas:

- Fish population status monitoring
- Hydro RME
- Tributary habitat RME
- Estuary and ocean RME
- Harvest RME
- Hatchery RME
- Predation and invasive species management RME
- Coordination and data management
- Project implementation and compliance monitoring

Fish Population Status Monitoring

For fish population status monitoring, the Action Agencies continued to monitor the status of ESA-listed fish and enhance the existing status monitoring performed by regional fish management agencies. Fish population status monitoring was a key component of intensively monitored watersheds (IMW) in the Wenatchee, Methow, Entiat, Okanogan, Lemhi, South Fork Salmon, Yakima, and John Day subbasins. Supplemental fish population status information was also obtained through multiple hatchery and habitat effectiveness research and monitoring projects throughout the Columbia Basin. The Action Agencies continued extensive status monitoring of adult and juvenile migration through the hydrosystem and provided ongoing support for a regional PIT tag information system. More than 90 percent of Action Agency funded hatchery fish were marked to enable tracking of hatchery-origin fish on the spawning grounds.

Hydro RME

Hydro RME studies were conducted on the juvenile fish transportation program, turbine survival, water temperature, and juvenile and adult dam passage survival and passage efficiency. The Action Agencies expanded coverage in detecting PIT-tagged fish and improved the ability to evaluate new and alternative fish passage operations and technologies.

Tributary Habitat RME

Tributary habitat RME studies were conducted to identify habitat conditions and limiting factors in pilot IMW areas, and to quantify the relationships between habitat conditions and fish productivity. This information is being used to develop

and parameterize models used to plan and implement habitat actions and assess expected survival benefits of habitat actions.

Estuary and Ocean RME

Estuary and ocean RME studies were conducted to evaluate fish performance and life history diversity relative to various habitat areas and key environmental attributes. The bathymetry and topography of the estuary continued to be mapped, and work was implemented to establish a habitat classification system and index of habitat connectivity. The effects of individual habitat actions were assessed and a methodology for estimating the cumulative effects of habitat projects was further developed. Critical uncertainty research was conducted on the importance of different tidal freshwater, estuary, plume, and nearshore ocean environments, and development of a hydrodynamic numerical model to evaluate contemporary and future habitat changes caused by climatic and anthropogenic effects and to describe the temporal and spatial features of the Columbia River estuary and plume that are important for salmon in relation to ocean conditions. Early ocean migration and survival studies continued to be implemented and refined.

Harvest RME

Harvest RME investigations linked to FCRPS interests included feasibility studies for Zone 6 harvest PIT-tag recoveries to help refine upstream adult survival rates. Selective fishing methods and gear were evaluated. Support was continued for coded-wire tagging and recovery operations needed to assess the survival, straying, and harvest rates of specific hatchery fish stocks. Further work was advanced on genetic stock identification techniques.

Hatchery RME

Hatchery RME studies were conducted to assess the effects that hatchery programs and implemented reform actions have on native populations. The relative reproductive success (RRS) of hatchery-origin fish compared to natural-origin fish continued to be assessed for several ESA-listed salmon and steelhead populations. Plans continued for expansion of the RRS work to other populations.

Predation and Invasive Species Management RME

Predation RME studies were conducted to evaluate and monitor the Northern Pikeminnow Management Program, avian predation rates on juvenile salmon in the lower Columbia River, and predation rates of California sea lions on adult salmon below Bonneville Dam. Management plans were further advanced for predator management, and studies on the effectiveness of predation management actions were implemented.

Coordination and Data Management, Project Implementation and Compliance Monitoring

The Action Agencies continued to coordinate RME planning and implementation through the Corps' Anadromous Fish Enhancement Program and the project planning and review efforts of the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program. Through the Action Agencies' participation and leadership in regional coordination forums, such as PNMAP and the Northwest Environmental Data Network, they continued their support for standardization and coordination of tagging and monitoring efforts and data management. Significant funding and staff support was provided for data system components that support the information management needs of all RME strategies.

2008 Accomplishments

What are our goals and strategies?	What are our key initiatives?	What are our key accomplishments?
HYDROSYSTEM		
Increase the survival rates of fish passing through mainstem dams: • Configure dam facilities to improve juvenile and adult fish passage survival • Manage water to improve juvenile and adult fish survival • Operate and maintain fish passage facilities to improve fish survival	• Operate and maintain adult fish ladders and other fish facilities • Guide juvenile fish away from turbines • Improve passage routes through the dams for juvenile fish to achieve 96 percent dam survival for spring Chinook and steelhead and 93 percent dam survival for subyearling fall Chinook • Manage available water to improve conditions for migrating fish • Transport juvenile fish in barges or trucks past dams in a "spread-the-risk" approach • Track migrating fish with passive integrated transponder (PIT) detection systems • Implement kelt management and reconditioning to improve steelhead productivity	• Water Management, Fish Passage, and Water Quality Plans completed and followed • 2008 testing at some dams shows where the performance standard (PS) may be met, partially met, or exceeded. The following actions were implemented to achieve PS: - At Bonneville Dam, installed an improved behavioral guidance screen that increased the number of yearling Chinook passing through the corner collector (the route with the highest survival rate); implemented a new spill operation that substantially improved spillway survival for yearling and subyearling Chinook - At John Day Dam, operated and tested two new top spill weirs (TSW); turbine entrainment was reduced by 50 percent or more - At Ice Harbor Dam, concrete survival remained high for all three species. Relative survival estimates were equal or better than the BiOp performance standards under all operations. - At Lower Monumental Dam, installed and tested a new removable spillway weir (RSW) in 2008; survival via the RSW exceeded all other passage routes - Started construction of both an adjustable spillway weir at Little Goose Dam (installed early 2009) and a relocated outfall for juvenile bypass system at Little Goose Dam - Completed construction of flow deflectors on all 19 spillway bays at Chief Joseph - Replaced two of three gear shafts on the Ice Harbor fish ladder, which will improve hydraulic conditions for adult fish • BPA funded CRITFC to prepare a Kelt Master Plan to help address reconditioning as part of the broader Kelt Management Plan
PREDATOR MANAGEMENT		
Reduce the number of juvenile fish consumed by predators: • Redistribute avian predators • Reduce fish predation • Manage sea lion predation	• Provide alternative Caspian tern habitat in the Western Region to encourage redistribution (began in 2008, will complete around 2012) • Gradually reduce tern habitat in the Columbia River estuary, after alternative habitat is provided in other locations; reduce annual juvenile salmonid consumption by Caspian terns in the estuary to approximately 2.5 million fish • Provide incentives to reduce the number of large northern pikeminnow in the Columbia River • Address presence of sea lions below Bonneville Dam • Monitor predation by sea lions below Bonneville Dam • Initiate further baseline research and development of a future draft environmental impact statement to determine whether double-crested cormorant management is warranted	• Created 2.5 acres of alternative habitat for Caspian tern nesting at three locations in Oregon: Crump Lake, Fern Ridge, and Summer Lake • Continued baseline research and a feasibility study of potential management techniques to reduce cormorant predation on juvenile salmon in the Columbia River estuary • Began discussions with the U.S. Fish and Wildlife Service to develop an avian management plan for Corps-owned lands in the middle Columbia • Continued hazing of sea lions below Bonneville Dam and installed sea lion exclusion devices (SLEDs) at Bonneville Dam • Monitored sea lion abundance, predation, and distribution and the effectiveness of deterrent activities below Bonneville Dam • Removed more than 162,000 northern pikeminnow from the Columbia River in 2008; reduced their predation of juvenile salmon by about 38 percent since 1990 • Increased northern pikeminnow tagging for evaluative purposes by more than 70 percent over previous years

2008 Accomplishments

What are our goals and strategies?	What are our key initiatives?	What are our key accomplishments?
HABITAT		
Improve tributary and/or estuary habitat used by salmon for spawning or rearing: • Protect and improve tributary habitat based on biological needs and prioritized actions • Improve juvenile and adult fish survival in estuary habitat	Tributary • Increase streamflow via water acquisitions • Address entrainment through screening • Provide fish passage and access • Improve mainstem and side-channel habitat conditions • Protect and enhance riparian conditions Estuary • Acquire, protect, and restore off-channel habitat • Restore tidal influence and improve hydrologic flushing • Restore floodplain reconnection by removing or breaching dikes or installing fish-friendly tide gates • Remove invasive plants and weeds; replant native vegetation • Protect and restore emergent wetland habitat and riparian forest habitat • Restore channel structure and function • Develop and implement a piling and pile dike removal program	Tributary • Secured 230 cubic feet per second (cfs) in additional streamflows throughout tributaries in the basin. The new transactions in 2008 totaled 37,937 acre-feet instream, with up to 92,482 acre-feet and 366 cfs instream in 2008 when combined with the flows from long-term transactions during 2003–2007. • Addressed fish entrainment in four locations • Improved or opened access to more than 260 miles of spawning and rearing habitat • Improved more than 170 acres of floodplain and wetland habitats, placed more than 300 instream structures, increased the complexity of almost 60 stream miles, and realigned, connected, or created about 44 acres of stream channels • Planted more than 600 acres of riparian vegetation, leased or purchased more than 9,500 acres of riparian habitat, and improved or relocated more than 35 miles of roads affecting riparian areas Estuary • Improved and restored 6 linear miles of stream/channels • Restored 60 acres of floodplain • Planted and maintained native vegetation for 285 acres • Removed invasive plant species from 303 acres • Restored 57 acres of riparian areas • Installed fencing for 5 miles • Funded acquisition of 380 acres of land for protection and/or restoration
HATCHERIES		
Use hatcheries to address the biological priorities of salmon: • Implement safety-net programs to avoid extinction • Reduce potentially harmful effects of artificial production	• Intervene with artificial production techniques to avoid extinction of fish populations facing a high risk of extinction • Modify hatchery practices or facilities if needed	• Funded safety-net hatchery programs that reduced the extinction risk of populations of Snake River sockeye, spring/summer Chinook, fall Chinook and steelhead, and Middle and Lower Columbia steelhead • Funded the final phase of draft Hatchery Genetic Management Plans. As these plans are reviewed and approved by NOAA Fisheries, they may be used to identify and prioritize facilities and practices for reform

2008 Accomplishments

What are our goals and strategies?	What are our key initiatives?	What are our key accomplishments?
RESEARCH, MONITORING AND EVALUATION		
Provide information needed to support planning and adaptive management and demonstrate accountability. The Action Agencies are undertaking RME through project implementation and compliance monitoring, status monitoring, action effectiveness research, and critical uncertainties research in nine strategic areas.	Implement RME in nine strategic areas: • Fish population status monitoring • Hydro RME • Tributary habitat RME • Estuary and ocean RME • Harvest RME • Hatchery RME • Predation and invasive species management RME • Coordination and data management • Project implementation and compliance monitoring	• Monitored status of selected fish populations related to FCRPS actions • Monitored and evaluated fish survival, migration characteristics, and river conditions within the FCRPS • Monitored and evaluated effects of configuration and operation of the FCRPS • Investigated critical uncertainties related to hydropower operations and investigated new technologies • Monitored and evaluated tributary habitat conditions and limiting factors and evaluated the effectiveness of tributary habitat actions • Monitored and evaluated estuary and nearshore ocean fish performance, migration characteristics, and environmental conditions • Monitored and evaluated the effects of habitat actions in the estuary • Investigated critical uncertainties related to the estuary and ocean • Implemented select harvest investigations linked to FCRPS interests • Monitored hatchery management effectiveness and investigated critical uncertainties related to hatcheries • Monitored and evaluated piscivorous, avian, and marine mammal predation and the effectiveness of management actions • Coordinated RME activities with other federal, state, and tribal agencies • Ensured that information is archived in appropriate data management systems • Monitored and evaluated implementation of Action Agency RPA actions

Overview by Species

The following summaries primarily describe abundance and abundance trends at the species or ESU level. However, species-level status for the purposes of salmon recovery planning is determined based on a review of population-level status and includes consideration not just of abundance but also productivity, spatial structure, and diversity; these are known as the viable salmonid population (VSP) attributes or parameters. The following section includes a brief review of some of the population-level information in the 2008 FCRPS Biological Opinion, which contains a much more thorough review of the status of independent populations within each ESU. Figures 19 through 25 display natural spawners only (with the exception of sockeye populations, which are sustained through a captive broodstock program).8 Population-level estimates of abundance and productivity have not been updated since the BiOp was issued.

Snake River Fall Chinook Salmon

The Snake River fall Chinook salmon ESU was listed under the ESA as a threatened species in 1992. This ESU is composed of only one extant population, which spawns and rears in the mainstem Snake River and in the lower reaches of its major tributaries below Hells Canyon Dam. It is estimated that 85 percent of the ESU's historical spawning habitat was lost as a result of construction of the privately owned Hells Canyon dam complex, which blocks all fish passage.

The most recent 10-year average return of natural-origin fish (through 2007) is estimated to be 2,358 adults. The most recent 4-year average return is 2,521 adults. Estimates of natural-origin adult abundance are not yet available for 2008.

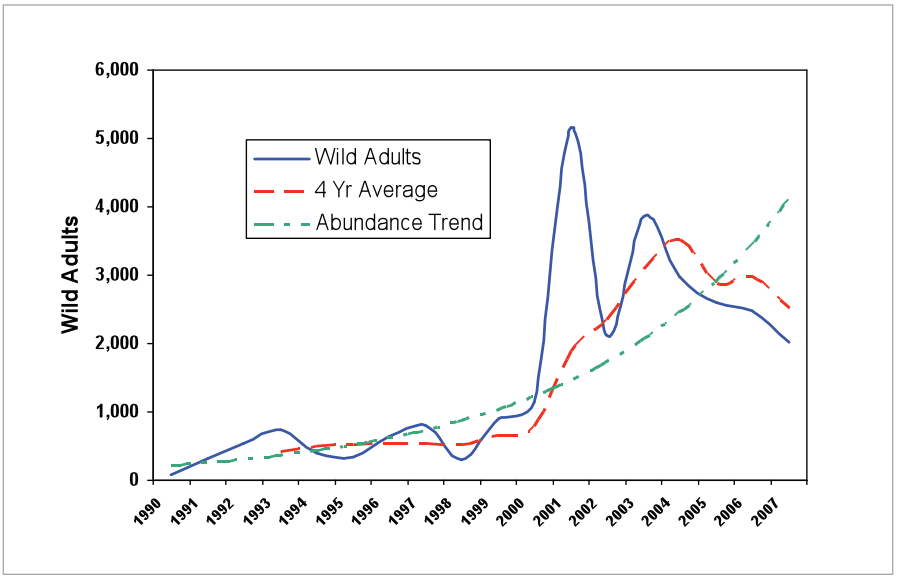

Figure 19. Returns of Naturally Produced Adult Snake River Fall Chinook Salmon. [9]

Returns of natural-origin Snake River fall Chinook salmon have trended upward since 1990. The FCRPS Biological Opinion considered trends of natural-origin adults based on two time periods with differing management actions and climate: 1977-2004 and 1990-2004. Although abundance trends were positive for both periods, productivity measured as returns-per-spawner (R/S) were positive only for 1990-2004. These estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem and other management improvements,

Snake River Spring/Summer Chinook

The Snake River spring/summer Chinook salmon ESU was listed under the ESA as a threatened species in 1992. The ESU is composed of 28 extant populations in five major population groups. The populations in this ESU spawn and rear in the tributaries of the Snake River between its confluence with the Columbia River and the Hells Canyon Dam.

The most recent 10-year average return of natural-origin Snake River spring/summer Chinook salmon was 18,156 adults. The most recent 4-year average return was 10,757 adults. An analysis of adult returns from 1990-2008 indicates that the ESU-level trend in abundance was positive during this period.

The FCRPS Biological Opinion considered population-level information based on adult returns from 1984-1986 through 2003-2005. Population-level abundance trends of natural-origin adults during this time period were generally positive. However, recruit-per-spawner productivity estimates were generally negative. These estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem and other management improvements.

[8] *A large percentage of each evolutionarily significant unit (ESU) is composed of hatchery fish, which are not displayed in the figures.*

[9] *Abundance charts in this report show ESU-level abundance from 1990 until the most recent available observation, consistent with the 2008 BiOp's "short-term" trend estimation period. Estimates are of naturally produced adult returns provided by NOAA Fisheries for all ESUs except Middle Columbia River steelhead.*

Table 3 summarizes the tributary habitat metrics completed since 2005 with Action Agency support in areas used by Snake River spring/summer Chinook.

Table 3. Snake River Spring-Summer Chinook Tributary Habitat Metrics, 2005-2008.

Metric	2008	2005-2008
Acre-feet/year of water protected	10,049.7	43,384
Acres improved	453.4	1,463.9
Acres protected	150.5	845.3
Water flow protected (cfs)	116	406.3
Miles of enhanced or newly accessible habitat	42.6	190.7
Miles of improved stream complexity	2.78	9.11
Miles protected	7.73	32.09
Screens installed or addressed	9	29

Source: See Habitat Metrics by Fiscal Year report available at http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx. Metrics do not include upland areas.

Snake River Sockeye Salmon ESU

The Snake River sockeye salmon ESU was listed under the ESA as endangered in 1991. The ESU includes all anadromous and residual sockeye in the Snake River basin, as well as the artificially propagated fish from the Redfish Lake Captive Broodstock Program. This species was thought by some to be functionally extinct at the time of its listing. It had suffered from significant long-term harvest pressures, a state-sponsored program to eradicate it from many of its natal lakes, private dams with little or no fish passage, the construction of the federal dams on the lower Snake River, and a major detrimental ocean/climate shift in the mid 1970s. An experimental captive broodstock program was initiated at the time of listing in an effort to forestall complete extinction in the near term. The program has achieved its original purpose and is now being expanded to help support recovery.

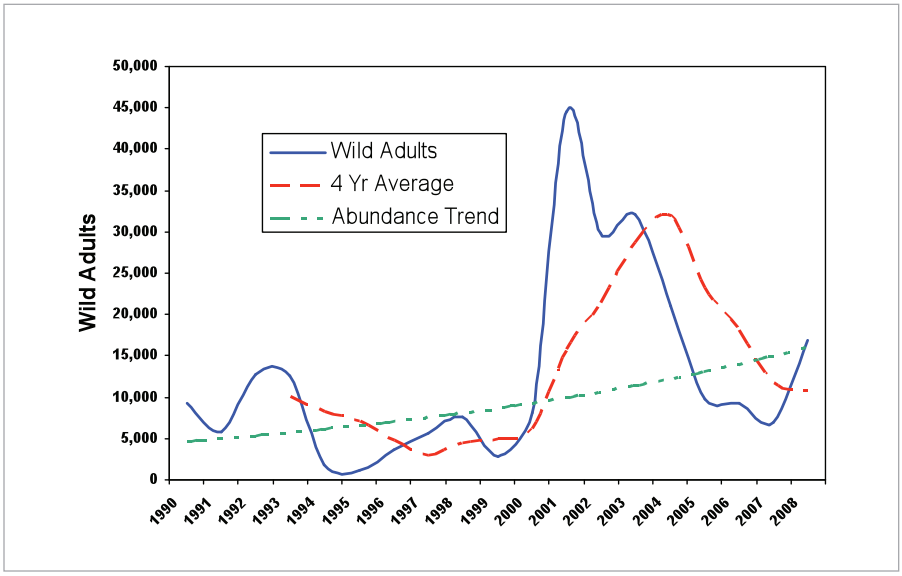

Figure 20. Returns of Naturally Produced Adult Snake River Spring/Summer Chinook Salmon.

The average annual adult return from the captive broodstock program between 1991 and 1999 was 11 fish. The average return from 2004 to 2007 was 50 fish. The year 2008 saw an extraordinary return of 907 fish counted at Lower Granite Dam. This was the largest return since 1968. The Northwest Fisheries Science Center attributed the increased numbers to favorable ocean conditions and an increase in smolt releases from the captive broodstock program (*Factors Affecting Sockeye Salmon Returns to the Columbia River in 2008*, by NOAA-NWFSC, 2009).

Snake River Steelhead DPS

The Snake River steelhead distinct population segment (DPS) was listed as threatened in 1997. The DPS is composed of 24 individual populations in five major population groups. Inland steelhead of the Columbia River basin, and especially the Snake River DPS, are commonly referred to as either A-run or B-run. These designations are based on migration timing, age, and size at return. There is only marginal information regarding the status of most individual populations of Snake River steelhead, but it is believed that B-run steelhead spawn almost entirely in the Clearwater and Salmon rivers, while A-run steelhead occur throughout the Snake River basin.

The most recent 10-year average return of natural-origin Snake River steelhead was 21,834 adults (1999-2008). The most recent 4-year average return was 16,280 adults. An analysis of adult returns from 1990-2008 indicates that the DPS-level trend in abundance was positive during this period.

For most populations in this DPS, the 2008 FCRPS Biological Opinion applied "average" A-run and B-run population profiles, based on counts of returning adults at Lower Granite Dam. Based on these profiles, the BiOp concluded that most individual A-run populations in the DPS have trended upward since 1990, while B-run populations have not. Recruit-per-spawner productivity estimates have been positive for A-run populations generally over the 20-year period, but not for most B-run populations. These estimates represent average survivals during the periods in question and do not fully reflect survival improvements.resulting from more recent hydrosystem and other management improvements.

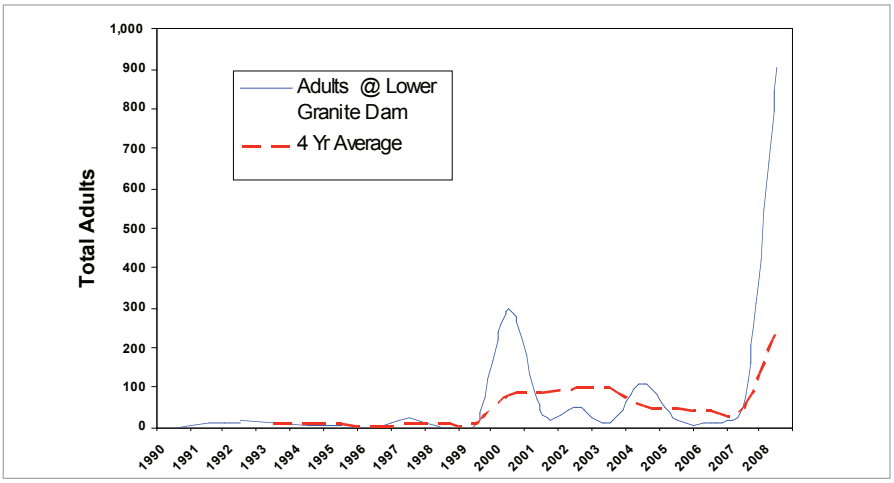

Figure 21. Returns of All Snake River Sockeye Salmon.

Data from Columbia River DART (Data Access in Real Time): http://www.cbr.washington.edu/dart/Snake River Steelhead DPS. Snake River sockeye salmon survival benefited in 2008 from hydro, habitat, predator control, hatchery, and harvest actions.

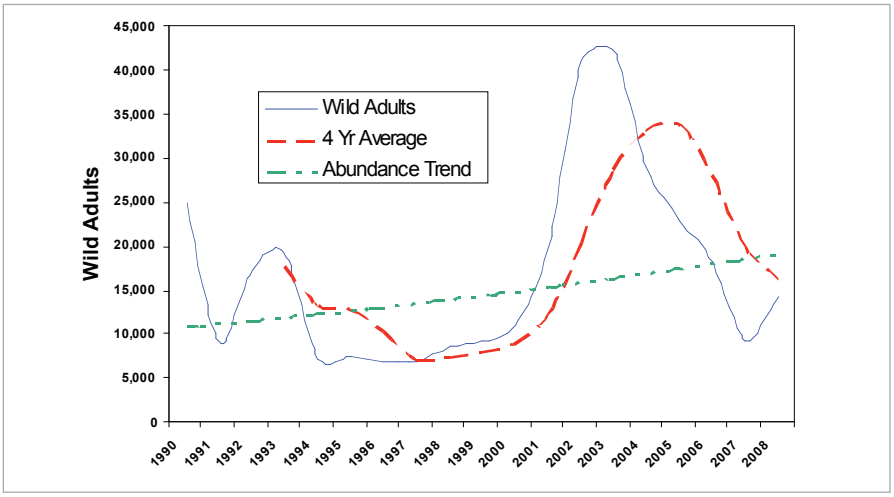

Figure 22. Returns of Naturally Produced Adult Snake River Steelhead.

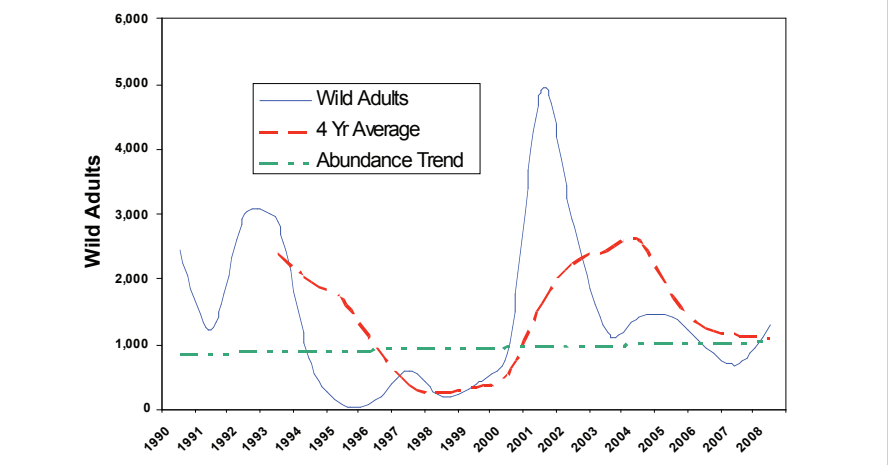

Figure 23. Returns of Naturally Produced Adult Upper Columbia River Spring Chinook Salmon.

Table 4 summarizes the habitat measures completed since 2005 with Action Agency support in areas used by Snake River steelhead.

Table 4. Snake River Steelhead Tributary Habitat Metrics, 2005-2008.

Metric	2008	2005-2008
Acre-feet/year of water protected	10,049.7	43,384
Acres improved	574.7	1,866.3
Acres protected	150.5	846.3
Water flow protected (cfs)	116	406.3
Miles of enhanced or newly accessible habitat	54.1	208.4
Miles of improved stream complexity	4.18	39.01
Miles protected	7.73	32.19
Screens installed or addressed	9	29

Source: See Habitat Metrics by Fiscal Year report available at http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx. Metrics do not include upland areas.

Upper Columbia River Spring Chinook Salmon

The Upper Columbia spring Chinook salmon ESU was listed as endangered in 1999. The ESU consists of three extant populations in one major population group. These populations spawn and rear in the mainstem Columbia River and its tributaries between Rock Island Dam and Chief Joseph Dam (a barrier to upstream migration).

The most recent 10-year average return of natural-origin Upper Columbia River spring Chinook salmon was 1,612 adults (1999-2008). The most recent 4-year average return was 1,110 adults. An analysis of adult returns from 1990-2008 indicates that the ESU-level trend in abundance remained generally flat during this period.

The FCRPS Biological Opinion considered population-level information based on adult returns from 1984 through 2003. The BiOp concluded that 1990–2003 abundance trends for the Wenatchee River and Entiat River populations were generally stable, while the Methow River population saw a slight decline over that period. During the 1984-2003 base period analyzed in the BiOp, these populations failed to replace themselves. These estimates represented average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem and other management improvements.

Table 5 summarizes the habitat measures completed since 2005 with Action Agency support in areas used by Upper Columbia River spring Chinook.

Table 5. Upper Columbia River Spring Chinook Tributary Habitat Metrics, 2005-2008.

Metric	2008	2005-2008
Acre-feet/year of water protected	2,558.6	4,870.9
Acres improved	0.1	0.1
Acres protected	93	191.4
Water flow protected (cfs)	24.3	34.5
Miles of enhanced or newly accessible habitat	0	0.8
Miles of improved stream complexity	0.1	0.1
Miles protected	0.47	2.22
Screens installed or addressed	0	0

Source: See Habitat Metrics by Fiscal Year report available at http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx. Metrics do not include upland areas.

Upper Columbia River Steelhead

The upper Columbia River steelhead DPS was listed as endangered in 1997 but was recently relisted as threatened. The DPS consists of four populations in one major population group. These populations spawn and rear in the rivers and tributaries draining the eastern slope of the Cascade Mountains upstream of Rock Island Dam.

The most recent 10-year average return of natural-origin Upper Columbia River steelhead was 2,669 adults (1998-2007). The most recent 4-year average return was 2,628 adults. An analysis of adult returns from 1990-2007 indicates that the ESU-level trend in abundance was positive during this period.

The FCRPS Biological Opinion considered population-level information based on adult returns from between 1985 or 1986 through 2004 or 2005, depending on the population. Hatchery returns have dominated natural spawning in all populations in this DPS. Historical broodstock protocols included the use of out-of-basin broodstock and extensive mixing of stocks from different populations within the DPS. This may be a major contributor to the poor productivity seen in these populations.

The BiOp concluded that short- and long-term abundance trends for all populations were positive. During the 20-year base period analyzed in the BiOp, these populations failed to replace themselves. The estimates represent average survivals during the periods in question and do not fully reflect survival improvements resulting from more recent hydrosystem and other management improvements.

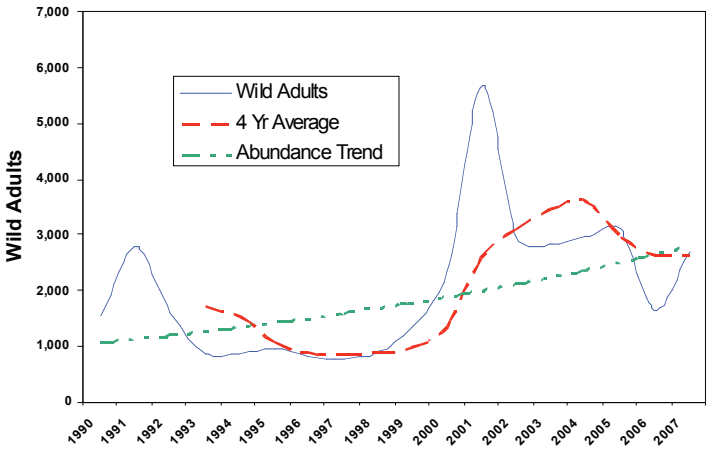

Figure 24. Returns of Naturally Produced Adult Upper Columbia River Steelhead.

Table 6 summarizes the habitat measures completed since 2005 with Action Agency support in areas used by Upper Columbia River steelhead.

Table 6. Upper Columbia River Steelhead Tributary Habitat Metrics, 2005-2008.

Metric	2008	2005-2008
Acre-feet/year of water protected	3,251.6	6,263.9
Acres improved	22.6	23
Acres protected	193	291.4
Water flow protected (cfs)	49.3	84.5
Miles of enhanced or newly accessible habitat	0	0.8
Miles of improved stream complexity	0.1	0.1
Miles protected	0.97	2.72
Screens installed or addressed	0	0

Source: See Habitat Metrics by Fiscal Yearreport available at http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx. Metrics do not include upland areas.

Middle Columbia River Steelhead

The Middle Columbia River steelhead DPS was listed as threatened in 1999. The DPS is composed of 17 individual populations in four major population groups. These populations spawn in Oregon and Washington drainages upstream of the Hood River and Wind River systems up to and including the Yakima River basin. Almost all populations within this DPS are summer-run steelhead; the exceptions are the winter-run populations returning to the Klickitat and Fifteen Mile Creek watersheds.

The most recent 10-year average return of natural-origin Middle Columbia River steelhead was 17,201 adults (1996-2005). The most recent 4-year average return was 21,985 adults. An analysis of adult returns from 1990-2005 indicates that the ESU-level trend in abundance was positive during this period.

The 2008 FCRPS Biological Opinion considered population-level abundance estimates of natural-origin Middle Columbia River steelhead based on adult returns through 2004 or 2005. Eleven of the 13 populations for which adequate information is available had a positive trend in abundance since 1990. Over the most recent 10 years, the average abundance of three populations has been more than the minimum level needed for recovery, as identified by the Interior Columbia Technical Recovery Team. However, over the 20 years considered in the BiOp (concluding with the adult returns for 2004 or 2005), only eight of those 13 populations had positive recruit-per-spawner productivity.

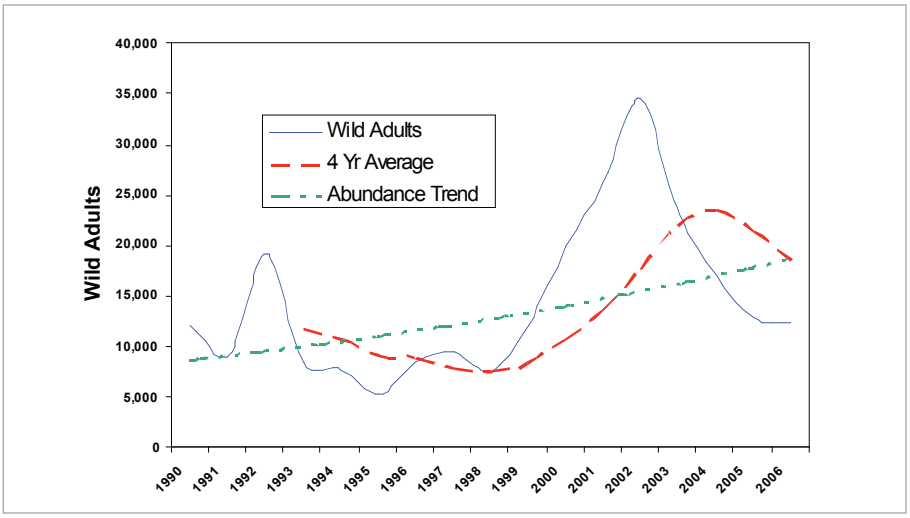

Figure 25. Returns of Naturally Produced Adult Middle Columbia River Steelhead (DPS Composite). [11]

Mid-Columbia steelhead survival benefited in 2008 from hydro, habitat, predator control, hatchery, and harvest actions.

Table 7 summarizes the habitat measures completed since 2005 with Action Agency support in areas used by Middle Columbia River steelhead.

Table 7. Middle Columbia Steelhead Tributary Habitat Metrics, 2005-2008.

Metric	2008	2005-2008
Acre-feet/year of water protected	1,638.3	17,592.1
Acres improved	691.6	2,221.6
Acres protected	9,472.4	11,831.3
Water flow protected (cfs)	8.2	111
Miles of enhanced or newly accessible habitat	219.3	366.85
Miles of improved stream complexity	41.5	51.04
Miles protected	169.13	464.39
Screens installed or addressed	37	112

Source: See Habitat Metrics by Fiscal Year report available at http://www.efw.bpa.gov/IntegratedFWP/reportcenter.aspx. Metrics do not include upland areas.

Lower Columbia and Willamette River ESUs

These ESUs are currently threatened by a broad array of habitat and other environmental factors. Because they largely do not migrate through the federal dams on the Columbia and lower Snake rivers, the proposed operation of the Columbia/Snake projects of the FCRPS has a limited impact on these populations and there is limited potential to improve their status with improvements to these dams. The Action Agencies will provide an update on the status of these ESUs as part of the Comprehensive Evaluations called for in 2013 and 2016.

[11] *The DPS estimate is based on a composite of multiple data sources compiled by Fisher Fisheries.*

2008 Adaptive Management Summary

The FCRPS BiOp is premised on adaptive management and accountability for results. The Action Agencies use the best available scientific information to achieve performance standards and make needed adjustments so that actions meet the BiOp goals. Based on 2008 research and implementation, the Action Agencies have developed questions and identified issues that affect BiOp implementation. This information will be used to inform future actions and the 2010-2012 Implementation Plan under development now.

For hydropower mitigation, the Action Agencies have observed the following:

- Dam modifications and spill/surface passage improvements appear to be on track to achieve the hydrosystem performance standards of 96 and 93 percent average dam survival for spring and summer migrating fish, respectively.
  - The Configuration and Operational Plan for Ice Harbor Dam was not finalized by the end of 2008. However, current improvements appear to be on track to achieve performance standards at the dam.
  - Unusually high debris loading at Bonneville Dam during the spring of 2008 that required the turbine intake screens to be removed, which may have led to reduced in-river survival of yearling Chinook, is not expected to reoccur with a frequency that would require adaptive changes to the operation. Reduced survival at John Day Dam in the summer of 2008 as a result of predation will be addressed by increasing hazing activities, increasing the coverage of avian deterrent wires, and installing a new spillway deflector, which will allow more flexibility in spill operations.
  - New installation and operation in 2008 of surface passage at Lower Monumental and McNary dams are already on track for achievement of hydro performance standards.
- Studies in 2008 confirmed that each dam presents unique circumstances and passage routes that must be considered to provide optimum passage and meet performance standards. Increased dam survival is not always associated with increased spill volumes. The relationship between dam survival, spill passage efficiency, and passage delay at individual dams will continue to be a focus in future years.
  - Surface passage structures often pass a greater number of fish with a lesser volume of water than do other passage routes. Surface passage allows migrants to pass at depths where juveniles naturally migrate and oftentimes reduces forebay delay. Snake River surface passage improvements are nearly complete, after which the focus in future years will shift toward the lower river dams, particularly McNary, John Day, and The Dalles.
  - Optimizing project operations to provide good passage for juveniles while not impacting adult upstream passage is critical. In previous years, adult passage studies have shown increased fallback and lower escapement rates under higher spill levels.
- COMPASS modeling predictions/ performance metrics for in-river survival in 2008 were generally met. Although point estimates for in-river survival were somewhat lower than what the COMPASS model predicted, they fell within the expected confidence range. This difference may be explained by the unusual high debris issue at Bonneville Dam, as noted above.
- Adult return data continue to confirm that May transportation provides higher adult returns than in-river migration for steelhead, and somewhat higher returns for Chinook. Nevertheless, under adaptive management (as discussed with the Regional Implementation Oversight Group), the Action Agencies are continuing to spill during this time period and monitoring the adult return data to see whether this relationship changes based on improved in-river conditions.
  - However, a 2008 report by NOAA suggests that, from McNary Dam, transported and in-river migrants realize similar survival to the returning adult stage.
  - Preliminary results in a report by Kintama Research suggest that there are no significant differences in the survival of transported and in-river migrants during the estuarine and nearshore marine portions of the Chinook life cycle. Additional information will be collected to better access survival rate.
- Pursuant to court-ordered operations, spill was continued through August 31, 2008, regardless of the 300-fish trigger in the BiOp. However, that trigger would have resulted in spill through August 30 in 2008 in any case. The range of dates observed in recent years for this trigger has been August 1 to August 30.

For habitat mitigation, the Action Agencies have observed the following:

- The habitat program structure, which consists of biologically targeted projects, assessment of habitat quality improvements, use of expert panels, and independent scientific review, is under way and overall functioning well.
  - Projects were implemented that improved habitat quality in 2008, and many new projects are ramping up for future implementation.
  - Several estuary projects were successfully completed in 2008. A few are behind schedule but are scheduled for completion in 2009. Many new estuary projects are under development for completion in 2009-2010.
  - Timely environmental review for habitat projects, including ESA review, has emerged as a concern. The Action Agencies will be exploring a streamlined process for ESA compliance with state and federal agencies.
- Tangible habitat benefits are being achieved by specific projects. For example:
  - Year-round flow was returned to previously dry sections of a Pahsimeroi River tributary, and in September 2008, Idaho Department of Fish and Game biologists counted two Chinook "redds," or nests. Adding water to a dry section of stream added prime spawning ground and provided almost immediate fish benefits.
  - Fixes to passage barriers in the Methow River resulted in recolonization of upstream habitat by spawners of listed fish; however, significant straying of hatchery adult steelhead into the recolonized tributary study areas also occurred.
  - For tributary habitat, Intensively Monitored Watershed (IMW) monitoring is under way to confirm survival improvement benefits. This represents a cutting-edge approach to

research and monitoring and also has potential in monitoring climate change conditions.

- For estuary and ocean habitat, the Juvenile Salmonid Acoustic Tag (JSAT) and Pacific Ocean Survival Tracking (POST) projects are tracking juvenile salmon survival and location. Although exact results varied, preliminary results indicate that mortality is significantly higher in the estuarine and marine phases of the salmonid life cycle than in the freshwater phase.

For predator management, the Action Agencies have observed the following:

- Predation has emerged as a serious issue for the survival of both juvenile and adult salmon and steelhead. Future management actions must focus on controlling predation by native and non-native species.
- Predation by Caspian terns on juvenile fish continues to suggest that successfully relocating much of the tern nesting colony away from East Sand Island, where fish are most vulnerable to predation, will reduce mortality of juvenile salmonids. Diet studies have shown that steelhead smolts appear to be particularly vulnerable to predation, especially by Caspian terns.
- However, total avian predation on young fish has increased as a result of a nearly threefold expansion of a colony of double-crested cormorants on East Sand Island and predation by terns and cormorants from other colonies (Crescent Island, Rock Island, Foundation Island, etc.).
- Successful management of avian predation must be based on a broader framework, both in terms of the geographical area covered and the community of all potential avian predators present within that area.
- Predation by northern pikeminnow is being successfully controlled, with significant survival benefits. Examination of predation by non-native species, such as shad, walleye, and bass, is under way. Management of non-native species predation may conflict with state management of exotic warm-water game species (walleye, largemouth and smallmouth bass, Northern pike, catfish, etc.) for sport fisheries.
- The amount of fish eaten by sea lions continued to increase in 2008, with an expanded catch estimate of 4,466 adult salmon and steelhead. Efforts by the states to remove sea lions is expected to help reduce growing marine mammal predation on returning adult fish.

For hatchery mitigation, the Action Agencies have observed the following:

- The majority of listed fish are still hatchery-based, and this balance between hatchery and wild fish is expected to continue for at least the next decade.
- The Snake River sockeye captive broodstock and conservation/supplementation program returned high numbers of adult fish in 2008. This indicates that we have potentially moved from handfuls of adult fish on the brink of extinction to a more stable base for this program, which will be expanded in future years under the BiOp.
- In contrast to the sockeye captive broodstock program, the captive broodstock program for spring Chinook in the Tucannon River continues to have disappointing results and has been unsuccessful in achieving its adult return goals.
- The Hatchery Scientific Review Group process under way in 2008 has developed useful guidelines for hatchery reforms, although each hatchery facility will have to be considered case by case.
- Studies of Hood River steelhead using DNA-based genetic parentage analysis showed that hatchery fish produced fewer adult offspring per parent than wild fish (demonstrating low relative reproductive success , or RRS) but that supplementation hatchery fish from local, wild broodstock produced larger numbers of offspring than traditional hatchery fish from non-local, multi-generation hatchery broodstock.
- Repeat-spawning wild-born female steelhead were seen to double their reproductive success by spawning a second time. This suggests that kelt reconditioning may represent a valuable resource for buffering local populations and reducing the risk of local extinction or loss of genetic diversity.

For harvest, the Action Agencies have observed the following:

- In the Colville selective fisheries study, the immediate release survival of summer/fall Chinook and steelhead was assessed for three gear types. Mortality was lowest for fish captured in the purse and beach seines (100 and 99 percent immediate release survival, respectively), compared to traditional hoop, dip, and tangle nets, which had only an 80 percent immediate release survival.

Regarding fish status, the Action Agencies have observed the following:

- Adult fish returns in 2008 were good, with counts of adult and jack summer Chinook, fall Chinook, and sockeye passing Bonneville Dam all exceeding the 10-year average and spring Chinook, steelhead, and coho counts being below the 10-year average. This is likely a result of both the survival improvements made in recent years and excellent ocean conditions. It is not likely that current levels will be sustained, and future variability is expected. We will be looking for overall trends that are stable and increasing at the species level.

Working with the Region

Regional efforts to protect and recover threatened and endangered fish in the Columbia River basin are comprehensive and reflect the complex life cycles of the fish themselves. Progress has been made each year by building step by step on each preceding year's successful effort. It will take many years to rebuild sustainable populations of some species.

The Action Agencies work with regional interests to improve regional coordination and collaboration, and to implement actions to strengthen Columbia River basin salmon and steelhead stocks. Tribal, state, and federal agency representatives are jointly looking at options for a better way to stabilize salmon and steelhead populations in the Columbia River basin and bring these fish back to sustainable levels. The Action Agencies work closely with the region through the federal-state-tribal Regional Implementation Oversight Group (RIOG), the Columbia Basin Fish Accords, and Northwest Power and Conservation Council Fish and Wildlife Program.

Regional Implementation Oversight Group for RPA Implementation

In 2008, the RIOG was established to provide high-level policy review for the Columbia River basin—to discuss and coordinate implementation of the FCRPS and related BiOps. The RIOG is the successor to the Policy Working Group formed in 2005 to address court concerns and collaborate on development of the BiOp. The RIOG involves federal, state, and tribal agencies actively engaged in salmon recovery efforts. The group reviews the Action Agencies' progress reports under the BiOp, considers adaptive management decisions based on emerging scientific information, evaluates contingency plans, and helps to resolve policy and technical disputes. The group encourages collaboration, accountability, and transparency for BiOp implementation. The RIOG structure includes technical subgroups for each H (e.g., the Technical Management Team or TMT) in order to support regional review.

Columbia Basin Fish Accords in Support of RPA Implementation

In 2008, the Action Agencies entered into the Columbia Basin Fish Accords with the Confederated Tribes of the Warm Springs Reservation of Oregon (Warm Springs), the Confederated Tribes of the Umatilla Indian Reservation (Umatillas), the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation), the Columbia River Inter-Tribal Fish Commission (CRITFC), the Confederated Tribes of the Colville Indian Reservation (Colvilles), the Shoshone-Bannock Tribes of Fort Hall, and the States of Idaho and Montana. (In addition, in 2009, the Action Agencies entered into an Estuary Habitat Memorandum of Agreement with the State of Washington.) These historical, long-term agreements are intended to support and strengthen RPA implementation, foster cooperation and partnership, and advance fish recovery for all. These partnerships help accomplish "on-the-ground" implementation of actions that are beneficial to listed fish.

During 2008, tribal, state, and federal partners launched new projects and expanded existing projects under the Columbia Basin Fish Accords. Projects under way include improvements in passage and assurance of sufficient water for the Walla Walla River's salmon populations, recovery of sockeye runs in Redfish Lake, installation of lamprey passage systems at Bonneville Dam, and numerous other projects designed to restore critical habitat from the estuary to the tributaries.

Northwest Power and Conservation Council Fish and Wildlife Program

Under the Northwest Power Act, the Northwest Power and Conservation Council works to protect, mitigate, and enhance Columbia Basin fish and wildlife and their related spawning grounds and habitat that have been affected by hydropower development. The Council's Columbia Basin Fish and Wildlife Program guides BPA's funding and must be taken into account by all federal agencies that manage, operate, or regulate hydropower dams in the basin. During 2007 and 2008, the Council reviewed and updated its program as required under the Northwest Power Act. The Council's amended program (finalized in 2009) can be found at *http://www.nwpcc.org/library/2009/2009-02.htm*.

Conclusion

In 2008, as the result of a multi-year collaboration process, the Action Agencies began implementing the 2008 FCRPS BiOps. This progress report summarizes our first year of implementation. Major dam improvements occurred, acres of habitat were improved, predators were controlled, and fish status was good overall. Working with our regional partners, the Action Agencies will build on these accomplishments in the years ahead.

For More Information on Regional Efforts:

- Pacific Coastal Salmon Recovery Fund: *www.nwr.noaa.gov/Salmon-Recovery-Planning/PCSRF/*
- Columbia River Inter-Tribal Fish Commission: *www.critfc.org*
- Upper Columbia United Tribes: *www.ucut.org*
- Columbia Basin Fish and Wildlife Authority: *www.cbfwa.org*
- Northwest Power and Conservation Council: *www.nwcouncil.org*
- Oregon Watershed Enhancement Board: *www.oregon.gov/OWEB/index.shtml*
- Washington Salmon Recovery Office: *www.governor.wa.gov/gsro/default.htm*
- Idaho Office of Species Conservation: *www.species.idaho.gov*
- *Federal Columbia River Power System 2008 Annual Report*, website links, and more information on federal agency efforts for salmon and steelhead: *www.salmonrecovery.gov*